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CHANGES IN THE PUMP FUNCTION OF THE HEART OF CHILDREN AT SHARP MOTOR ACTIVITY LIMITATION

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Abstract

This paper deals with the study of the features of changes in the parameters of the pumping function of the heart of children with different levels of physical fitness at a sharp limitation of motor activity. It was revealed for the first time that the heart rate in children systematically engaging in muscle training with a sharp limitation of motor activity during the first three weeks does not undergo any significant changes, and tends to increase only in the fourth week of hypokinesia. Children who do not systematically engage in physical activity and sports show changes in heart rate already at the beginning of the second week of hypokinesia and significant changes at subsequent weeks at a sharp limitation of motor activity. Stroke volume of blood in children systematically engaging in sports does not undergo any significant changes during all four weeks of the limited motor activity, i.e. hypokinesia. Children who do not engage in physical activity and sports had no reliable changes in their stroke volume of blood during all three weeks of hypokinesia, while in the subsequent, i.e., the fourth week of severe limitation of motor activity, the stroke volume significantly decreased.

Keywords: *pump function of the heart, school-aged children, injuries, hypokinesia, muscle training.*

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INTRODUCTION:

In most diseases associated with the musculoskeletal system, doctors recommend rest, i.e. limited motor activity. However, many researchers note that limiting muscle activity leads to significant changes in the human body [1- 3, 9, 10]. E.I. Kovalenko and N.K. Gurovskii note in their book "Hypokinesia" [3] that the prolonged limitation of motor activity is one of the factors contributing to the development of cardiovascular diseases in humans. A number of authors indicate a change in the heart rate during the transition from the usual motor activity to the limited one. Changes in the heart rhythm are described even for the four-hour stay of the test subjects in a special chair and during the period of 10-day hypokinesia [3, 5].

At the same time, the literature has a fair amount of works showing that the cardiac rhythm does not change upon limitation of the motor activity [2, 9], or that some increase in the heart rate occurs only at the end of the period of hypokinesia [4]. Basically, all these studies were carried out in adults. At the same time, the changes occurring in the parameters of the pump function of the children's heart, due to the transition from one motor activity to the diametrically opposite one, remain completely unclear.

Objective of the research was to study the reaction of the pump function of the heart of a developing organism to a sharp limitation of motor activity.

RESEARCH METHODS:

Heart rate (HR) and stroke volume of blood (SV) in children were recorded with the help of a rheo-attachment for computer analysis RPKA2-01, designed for operation in the medical hardware-software complexes. To determine the stroke volume, tetrapolar thoracic rheography was applied (W.I. Kubicek et al., 1966) [8].

Methods and organization of research

The studies were conducted at Kazan Institute of Orthopedics and Traumatology during two years. The parameters of the pump function of the heart of the children with fractures of the lower extremities, as well as with spinal injuries undergoing inpatient treatment were examined. Children were conditionally divided into two groups. The first group included children of 9-14 years of age systematically engaging in physical activity and sports before admitting the hospital. The total number of the children was 18 people.

The second group included children of the same age who did not systematically engage in physical culture and sports, i.e. referred by their health state to a special medical group, also with injured lower extremities or spinal traumas. The number of the children was 19 people.

RESULTS AND DISCUSSION:

CHANGES IN THE PUMP FUNCTION OF THE HEART OF CHILDREN AT SHARP MOTOR ACTIVITY LIMITATION

As our studies showed the heart rate at rest in children of 10-13 years of age systematically engaging in physical culture and sports (the main group) at admission to the hospital was 81.7±1.2 bpm. At the end of the first week of the limited motor activity, the heart rate was recorded at 76.4±0.9 bpm. This value was 5.3 bpm less than the initial values of the heart rate ($P<0.05$). By the end of the second week of the limited motor activity, we found an increase in heart rate in children systematically engaging in physical training and sports up to about 80 bpm. The heart rate during the second week of hypokinesia, in comparison with the heart rate obtained in the first week, showed increase of 3.4 bpm ($P<0.05$).

During the next three weeks of the limited motor activity the heart rate in children of the main medical group did not undergo any significant changes, remaining approximately at the level of 80-81 bpm. Consequently, the children who were systematically engaging in physical activities and sports before admitting the hospital, had decrease in their heart rate during the first week of the limited motor activity. However, by the end of the second week of hypokinesia, the heart rate in these children increased to about the level of baseline values and did not significant change during the next three weeks of the limited motor activity.

Analyzing HR values of children aged 10-13 years not engaging in physical activities and sports and referred to the special medical group for health reasons, it was revealed their heart rate was 87.7±1.3 bpm at admission to the hospital. This value was by 6 bpm higher than the HR of children of the same age in the main medical group ($P<0.05$). During the first week of the limited motor activity, the children referred for health reasons to the special medical group, had decrease in their heart rate to 81.1±1.7 bpm. A decrease in heart rate during the first week of hypokinesia, as compared with the initial data, was 6.6 bpm ($P<0.05$). During the second week of the limited motor activity no significant changes were observed in the HR values in this group of children, and they remained at the level of 81 bpm. At the end

of the third week of hypokinesia, the heart rate increased to 86.7±1.5 bpm. This value was 5.8 bpm higher than the heart rate obtained in the second week of hypokinesia (P<0.05). During the fourth week of the limited motor activity, a subsequent increase in the heart rate of children referred to a special medical group was observed and reached 91.4±1.4 bpm. This value was higher, as compared both with HR values recorded during the third week of hypokinesia and with the initial values of the pulse, by 4.7 and 3.7 bpm, respectively. (P<0.05). At week five of the limited motor activity, the heart rate did not change significantly, remaining at the level of 91-92 bpm.

Thus, summarizing the above, we can note that there is a significant decrease in heart rate of the children not engaging in physical activities and sports during the first week of hypokinesia. Low values of heart rate remain during the second week of the limited motor activity. By the end of the third week of hypokinesia, the heart rate of these children increases to about the baseline values. At the fourth week of the limitated motor activity, there is a further significant increase in heart rate, as compared with the values of the heart rate obtained during the third week of hypokinesia. During the fifth week of hypokinesia, the heart rate does not undergo significant changes.

CHANGES IN STROKE VOLUME OF CHILDREN AT SHARP MOTOR ACTIVITY LIMITATION

Stroke volume in children, systematically engaging in physical culture and sports (the main medical group), was 44.7±0.9 ml at admission to the hospital. During the first week of the limited motor activity, the systolic ejection increased to 53.6±0.7 ml. This value was higher by 0.9 ml, as compared with the initial values of the stroke volume (P<0.05).

At the end of the second week of hypokinesia, the stroke volume decreased to 45.4±0.8 ml, that is, approximately to the initial value. During the next three weeks of the limited motor activity, the stroke volume in children referred to the main medical group for health reasons did not undergo significant changes, remaining at the level of 45-44 ml. Consequently, the children systematically engaging in physical activities and sports, show an increase in systolic ejection during the first week of hypokinesia. However, by the end of the second week of the limited motor activity, the stroke volume in these children decreases almost to the initial values and subsequently does not undergo any significant changes during three weeks of hypokinesia.

Stroke volume in children not engaging in physical activities and sports, i.e. referred to the special medical group for health reasons, was 35.8 ± 1.1 ml at admission to the hospital, which was less by 0.9 ml, as compared with the stroke volume in children of the same age, referred to the main medical group for health reasons (P<0.05). the limited motor activity of a special medical group of children within one week resulted in the increased stroke volume up to 49.4±1.2 ml, which is by 13.6 ml higher as compared with the initial values of systolic ejection (P<0.05). During the second week of hypokinesia, the stroke volume in these children remained at a high level (49.7±0.9 ml). At the end of the third week of the limited motor activity, the stroke volume in children referred to a special medical group decreased up to 37.3±0.7 ml, that is, approximately to the initial value of systolic ejection. During the fourth week of hypokinesia, a decrease in stroke volume up to 31.7±0.7 ml was observed. Although this decrease in systolic ejection does not reach a reliable value, in comparison with that of the third week, however, the trend towards a decrease in stroke volume in these children persists. At the fifth week of hypokinesia, the stroke volume values did not undergo significant changes and remained at the level of 31-32 ml.

Therefore, stroke volume in children, not systematically engaging in physical activities and sports, increased significantly during the first week of limited motor activity, as compared with the initial values of the stroke volume. High levels of stroke volume persist also during the second week of hypokinesia. Stroke volume in children of this group decreases to the initial value at the end of the third week of limited motor activity. The tendency to decrease in SV persists during the fourth week of hypokinesia. During the fifth week of limited motor activity, no significant changes are observed in stroke volume (Table 1 and 2).

Table 1: Changes in the parameters of the pump function of the heart of children not engaging in physical training at a sharp limitation of motor activity.

Pump function parameters	Children Not engaging in physical activity and sports					
	Initial data	*week 1*	*week 2*	*week 3*	*week 4*	*week 5*
HR	87.7±1.3	81.1±1.7*	80.9±0.9	86.7±1.5*	91.4±1.4*	91.7±1.2
SV	35.8±1.1	49.4±1.3*	49.7±1.2	37.3±0.7*	31.7±0.4	32.4±0.7

Note: * - significant changes as compared with initial values: (P<0.05).

Table 2: Changes in the parameters of the pump function of the heart of children systematically engaging in physical training at a sharp limitation of motor activity

Cardiac pump function parameters	**In children systematically engaging in physical activity and sports**					
	Initial data	*week 1*	*week 2*	*week 3*	*week 4*	*week 5*
HR	81.7±1.2	76.4±0.9*	79.8±1.1*	78.1±0.7	80.1±1.7	81.4±1.9
SV	44.7±0.9	53.6±0.7*	45.4±0.8*	44.4±0.7	45.1±0.9	44.6±0.9
CO	3.6±1.2	4.0±1.4*	3.6±1.7*	3.5±1.3	3.6±0.9	3.6±1.5

Note: *significant changes as compared with initial values: (P<0.05).

CONCLUSION:

As our studies show, the children who were systematically engaging in physical activities and sports before admitting the hospital, had decrease in their heart rate during the first week of the limited motor activity. However, already by the end of the second week of hypokinesia, the heart rate in these children increased to about the level of baseline values and did not significant change during the next three weeks of the limited motor activity.

There is a significant decrease in heart rate of the children not engaging in physical activities and sports during the first week of hypokinesia. Low

values of heart rate remain during the second week of the limited motor activity. By the end of the third week of hypokinesia, the heart rate of these children increases to about the baseline values. At the fourth week of limited motor activity, there is a further significant increase in heart rate, as compared with the values of the heart rate obtained during the third week of hypokinesia. During the fifth week of hypokinesia, the heart rate does not undergo significant changes.

Analyzing the changes in heart rate at limited motor activity in the children referred to the main and special medical group for health reasons, we found that:

- Firstly - during the first week of hypokinesia, the values of heart rate in both groups of children decrease. However, a decrease in heart rate in children referred to the main medical group at limited of motor activity is less pronounced during the first week.
- Secondly - heart rate in children, referred to the main medical group for health reasons, rises in the second week of hypokinesia to about the initial value and thereafter does not undergo significant changes. While heart rate in children of special medical group remains low during the second week of hypokinesia. An increase in the heart rate to approximately the initial level in these children is observed only during the third week of hypokinesia. Moreover, there is a further significant increase in the heart rate of the children referred to a special medical group during the fourth week of limited motor activity, as compared with the initial values. High levels of heart rate persist also during the fifth week of hypokinesia.

Analyzing changes in the values of stroke volume we found that the stroke volume in children, not systematically engaging in physical activities and sports, increases significantly during the first week of limited motor activity, as compared with the initial values of the stroke volume. High levels of stroke volume persist also during the second week of hypokinesia. Stroke volume in children of this group decreases to the initial value at the end of the third week of limited motor activity. The tendency to decrease in SV persists during the fourth week of hypokinesia. During the fifth week of limited motor activity, no significant changes are observed in stroke volume.

Comparing the reaction of the stroke volume in the children, referred to the main and medical groups, to the limitation of motor activity, we can note that during the first week of hypokinesia there is an increase in systolic ejection in both groups. However, an increase in stroke volume in children of a special medical group is more expressed. Moreover, these children have high stroke volume levels persisting during the second week of limited motor activity. While stroke volume in children, referred to the main medical group, decreases by the end of the second week of hypokinesia to about the initial value and thereafter does not undergo significant changes during the next three weeks. Stroke volume in children referred to a special medical group decreases at the end of the third week of hypokinesia. The tendency to decrease in the systolic ejection in these children is also observed during the fourth week of hypokinesia.

SUMMARY:

1. It was revealed that the heart rate in children systematically engaging in muscle training with a sharp limitation of motor activity during the first three weeks does not undergo any significant changes, and tends to increase only in the fourth week of hypokinesia.
2. The control group of children, i.e. who do not systematically engage in physical activity and sports show changes in heart rate already at the beginning of the second week of hypokinesia and significant changes at subsequent weeks at a sharp limitation of motor activity.
3. Stroke volume of blood in young athletes systematically engaging in sports does not undergo any significant changes during all four weeks of hypokinesia.
4. Children who do not engage in physical activity and sports had no reliable changes in their stroke volume of blood during all three weeks of hypokinesia, however, its significantly decreased subsequently.
5. It was revealed that the heart rate in children systematically engaging in muscle training with a sharp limitation of motor activity during the first three weeks does not undergo any significant changes, and tends to increase only in the fourth week of hypokinesia.
6. The control group of children, i.e. who do not systematically engage in physical activity and sports show changes in heart rate already at the beginning of the second week of hypokinesia and significant changes at subsequent weeks at a sharp limitation of motor activity.
7. Stroke volume of blood in young athletes systematically engaging in sports does not undergo any significant changes during all four weeks of hypokinesia.
8. Children who do not engage in physical activity and sports had no reliable changes in their stroke volume of blood during all three

weeks of hypokinesia, however, its significantly decreased subsequently.

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