Research Article

Peculiarities of heart rate change among children with hypokinesis

B. I. Vakhitov[1]*, T. L. Zefirov[1], I. O. Pankov[2], I. H. Vakhitov[1]

ABSTRACT

Objective: The purpose of the study is to study the response of indicators of heart pumping function indicators among the children with a sharp restriction of their motor activity (hypokinesia). **Method:** The heart rate (HR) was recorded using the Reo assembly for computer analysis RPKA2-01, designed to work as the part of hardware and software complexes for medical purposes. Tetrapolar thoracic rheography was used to determine the HR. **Results:** They revealed the peculiarities of heart pumping function parameter change among the children with different levels of physical fitness, with a sharp limitation of motor activity. For the 1st time, they revealed that among the children who engage in muscle training systematically, with a sharp restriction of motor activity during the first 3 weeks, the HR does not undergo significant changes, and only by the 4th week of hypokinesia, there is the tendency to HR increase. **Conclusion:** The children with a sharp restriction of motor activity, who do not engage in physical activity and sports regularly, demonstrate HR changes at the beginning of the 2nd week of hypokinesia and their subsequent change at a significant pace.

KEY WORDS: Heart pumping function, Heart rate, Hypokinesia, Muscle training, School age children, Traumas

INTRODUCTION

In most diseases associated with the musculoskeletal system, doctors recommend rest, i.e., the restriction of motor activity. At that, many researchers note that the limitation of muscle activity leads to significant changes in a human body.[1-4] In the monograph "Hypokinesia," Kovalenko and Gurovsky[2] noted that a prolonged restriction of motor activity is one of the factors contributing to the development of cardiovascular diseases among people. A number of authors indicate the change of the heart rate (HR) during the transition from the usual motor regimen to the conditions of limited mobility. The changes in the heart rhythm are described even at a 4-h stay of the subjects in a special chair and during the 10-day hypokinesia.[2,5-7]

At the same time, quite often, there are the works in the literature which show that the cardiac rhythm does not change when the motor activity is limited or some increase of the HR occurs only at the end of hypokinesia period. It should be noted that most of the studies were carried out on an adult body. At that, the changes taking place in the parameters of the children's heart pumping function remain completely unclear due to the transition from one motor regimen to the diametrically opposite one.

At the same time, there are the works in the scientific literature that indicate the following: When the motor activity is limited, the heart rhythm either does not change[1,4,8,9] or slightly increases by the end of hypokinesia period.[10] Basically, all these studies were conducted among adults. At the same time, the changes occurring in the parameters of the child heart pumping function remain completely unclear due to the forced transition from one motor regimen to the diametrically opposite one.

The purpose of the study was to study the response of HR among the children with a sharp restriction of motor activity (hypokinesia).

STUDY METHODS

The HR among the children was recorded with the help of the Reo assembly for computer analysis RPKA2-01,

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[1]Department of Veterinary Medicine, Kazan State Academy of Veterinary Medicine Named After N.E. Bauman, Kazan Federal University, Kazan 420008, Russia, [2]Department of Veterinary Medicine, Kazan State Academy of Veterinary Medicine Named After. N.E. Bauman, Russia, Kazan, Sibirskiy Trakt 35, 420074, Russia

***Corresponding author:** B. I. Vakhitov, Department of Veterinary Medicine, Kazan State Academy of Veterinary Medicine Named After N.E. Bauman, Kazan Federal University, 18 Kremlevskaya Street, Kazan 420008, Russia.
E-mail: Bulat.vakhitov.1989@mail.ru

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designed to work as the part of hardware and software complexes for medical purposes. To determine the HR, tetrapolar thoracic rheography was used.[3] The principle of impedance electroplethysmography is to record the oscillations of the complex electrical resistance (impedance) of a bioobject to a high-frequency current; the fluctuations of resistance are proportional to blood supply changes. Enhanced by electronic devices and recorded graphically, these changes of resistance form a curve called rheogram (rheo - flow). The method has a number of undeniable advantages: Non-invasiveness and promptness, continuity and any duration of observation, technical simplicity and absolute atraumaticity, and the possibility of measurements at free breathing.

The studies were conducted at the Traumatology Center of the Republican Clinical Hospital of the Ministry of Health of the Republic of Tatarstan for 2 years. The parameters of the heart pumping function were studied among the children undergoing in-patient treatment, with the fractures of the lower extremities and spine traumas. Children were conditionally divided into two groups. The first (main) group included 18 children at the age of 9–14 years who were systematically engaged in physical culture and sports, before entering the hospital. The second (control) group consisted of 19 children of similar age and with similar traumas, who were not systematically engaged in physical culture and sports, classified for health reasons to a special medical group.

RESULTS AND DISCUSSION

As our studies showed, the children at the age of 10-13 years, systematically engaged in physical culture and sports (the main group), had the following HR at rest at the time of admission to the hospital: 81.7 ± 1.2 beats/min. At the end of the 1st week of motor activity limitation, the HR was 76.4 ± 0.9 beats/min. This value was 5.3 bpm less than the baseline values of HR ($P < 0.05$). By the end of the 2nd week of motor activity restriction among the children of the main group, we found that the HR increased to 80 beats/min. The increase of HR during the 2nd week of hypokinesia was 3.4 beats/min ($P < 0.05$) as compared with the HR obtained during the 1st week. During the next 3 weeks of motor activity limitation among the children assigned to the main medical group, the HR did not change significantly, remaining at the level of 80–81 beats/min.

Thus, during the 1st week of motor activity limitation, the HR decreases among the children who systematically engaged in physical culture and sports before entering the hospital. However, by the end of the 2nd week of hypokinesia, the HR of these children increases to about the level of baseline values and does not undergo significant changes during the next 3 weeks of motor activity limitation.

HR indices were 87.7 ± 1.3 beats/min during the admission to the hospital among 10–13-year-old children who did not engage in physical culture and sports and were referred to the special medical group for health reasons (the second observation group). This value was 6 beats/min higher than the HR of children of the same age referred to the main medical group ($P < 0.05$). During the 1st week of motor activity restriction among the children of the second group, the HR decreased to 81.1 ± 1.7 bpm. The decrease of HR during the 1st week of hypokinesia made 6.6 beats/min ($P < 0.05$) as compared with baseline data. During the 2nd week of the motor activity restriction, the HR among the children of the second group did not undergo significant changes, and they remained at the level of 81 beats/min. At the end of the 3rd week of hypokinesia, the HR increased to 86.7 ± 1.5 beats/min. This value was 5.8 beats/min higher than the HR values recorded during the 2nd week of hypokinesia ($P < 0.05$). During the 4th week of motor activity limitation, the subsequent increase of HR among the children of the second group was observed up to 91.4 ± 1.4 bpm. This value was higher, as compared with the HR values recorded during the 3rd week of hypokinesia and, as compared with baseline values, by 4.7 and 3.7 beats/min ($P < 0.05$), respectively. During the 5th week of motor activity limitation, the HR did not undergo significant changes, remaining at the level of 91–92 beats/min.

Thus, summarizing the mentioned above, it can be noted that the children not engaged in physical culture and sports demonstrate a significant decrease of HR during the 1st week of hypokinesia. Low values of HR remain also during the 2nd week of motor activity restriction. By the end of the 3rd week of hypokinesia, the HR among the children of the second group increases approximately to the initial values. During the 4th week of motor activity restriction, there is a further reliable increase of HR, as compared with the values of HR obtained during the 3rd week of hypokinesia. During the 5th week of hypokinesia, the HR does not undergo significant changes [Table 1].

SUMMARY

As our studies have shown, the children, systematically engaged in physical culture and sports before entering the hospital, demonstrate HR decrease during the 1st week of motor activity limitation. However, by the end of the 2nd week of hypokinesia, the HR of these children increases to about the level of baseline values and does not undergo any significant changes during the next 3 weeks of motor activity limitation.

Table 1: The changes of heart rate among the children who were not engaged and were systematically engaged in muscle training before entering the hospital

Characteristics	Hypokinesia stages					
	Source data	1st week	2nd week	3rd week	4th week	5th week
Heart rate of children engaged in physical training	81.7±1.2	76.4±0.9*	79.8±1.1*	78.1±0.7	80.1±1.7	81.4±1.9
Heart rate of children not engaged in physical culture	87.7±1.3	81.1±1.7*	80.9±0.9	86.7±1.5*	91.4±1.4*	91.7±1.2

*Reliable changes in comparison with baseline values ($P<0.05$)

The children, who are not engaged in physical culture and sports, demonstrate a significant decrease of HR during the 1st week of hypokinesia, and low values of HR persist during the 2nd week of motor activity restriction. By the end of the 3rd week of hypokinesia, the HR of these children increases to about the baseline values. During the 4th week of motor activity limitation, a further reliable increase of HR is observed, as compared with the values obtained during the 3rd week of hypokinesia. During the 5th week of hypokinesia, the HR does not undergo significant changes.

Analyzing the HR changes with the motor activity restriction among children classified by health status to the main and special medical groups, we found out:

1. During the 1st week of hypokinesia, the values of HR are reduced in both groups of children under study. However, the decrease of HR among the children assigned to the main group is less pronounced with the restriction of motor activity during the 1st week.
2. During the 2nd week of hypokinesia, the HR rises to about the initial value and thereafter does not undergo significant changes among the children classified by health status to the main medical group.
3. Low values of HR persist and during the 2nd week of hypokinesia among the children referred to a special medical group. The increase of HR to the baseline one among these children is observed only during the 3rd week of hypokinesia. Moreover, the children of this group demonstrate a further significant increase of HR during the 4th week of motor activity limitation, as compared with baseline values. High values of HR remain among them during the 5th week of hypokinesia.

CONCLUSIONS

(1) Among the children, who are systematically engaged in muscle training, the HR does not undergo significant changes with a sharp restriction of motor activity during the first 3 weeks, and HR increases only by the 4th week of hypokinesia. (2) Among the children of the control group who do not engage in physical exercise and sports, the changes of HR are observed already at the beginning of the 2nd week of hypokinesia, and the HR changes significantly during subsequent weeks.

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