

Heterochronic Changes in Parameters of Cardiac Pumping Function in Rat Pups

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Cardiac pumping function was studied in rat pups by thoracic tetrapolar rheography. The mean daily increment in blood stroke volume increased with age, while the mean daily changes in HR decreased starting from day 30 of life. Changes in the parameters of minute volume of circulation to a greater extent depended on stroke volume than on HR.

Key Words: *heterochronicity; blood stroke volume; HR; mean daily changes; rat pups*

Individual changes in HR and blood stroke volume (SV) under conditions of unrestricted motor activity, under conditions of different motor regimens and at rest are more pronounced in young animals than in adults [2-5]. Heterochrony is a characteristic feature of the pumping function of the heart during ontogeny [3,4,6]. Detection of the periods of accelerated development of the pumping function will help to determine conditions for more effective physiological treatment of the developing heart.

We studied manifestations of heterochronic development of cardiac pumping function in rat pups.

MATERIALS AND METHODS

Experiments were carried out on laboratory outbred albino rats aged 14, 21, 25, 28, 30, 32, 35, 40, 42, 49, 60, 65, and 70 days. The animals were kept under vivarium conditions.

The studies were carried out using a MacLab 4e analog digital transformer (ADInstruments). Differentiated rheogram was recorded on a 4 RG-2M rheographer in spontaneously breathing animals narcotized with sodium ethaminal (40 mg/kg). Blood stroke volume was evaluated by modified thoracic tetrapolar rheography [1]. The results were analyzed using special software. The data were processed by

methods of mathematical statistics using Student's *t* test and Excel software.

RESULTS

The mean daily increment in HR of 21-day-old rats vs. 14-day-old pups was 10.03 bpm, decreasing by the age of 30 days (Fig. 1). A reduction in the rate of mean daily changes in HR was detected on day 35 in comparison with the parameter in 30-day-old rats. The level of the mean daily changes in HR was the lowest in 70-day-old rats. Hence, the mean daily changes in HR during growth and development are nonuniform and age-dependent: the older the animal, the less pronounced are the mean daily changes in HR.

Results of analysis of the mean daily changes in SV of rat pups are presented in Fig. 2. The absolute SV values increased with age, while the mean daily changes in this characteristic had a different trend. The mean daily changes in SV of rat pups aged 21, 25, and 28 days were the same. The parameter markedly increased from day 30 until day 42 of life. Starting from day 49 the mean daily increment in SV somewhat decreased, and by days 60, 65, and 70 the differences in the parameter were negligible. Hence, the mean daily changes in SV, similarly as in HR, were heterochronic.

We found that minute blood volume (MBV) correlates with HR and SV. Multiple coefficient of cor-

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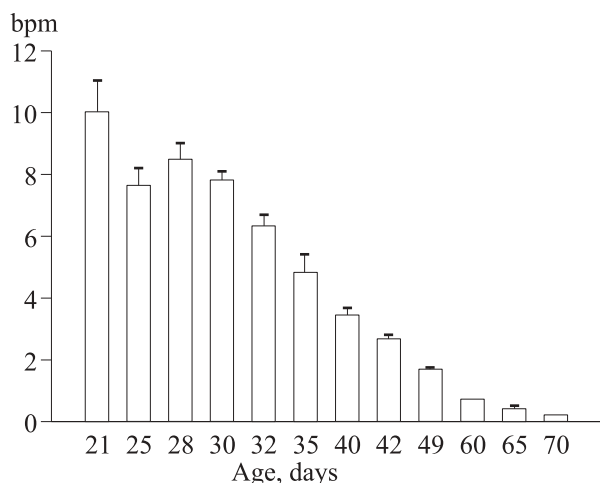


Fig. 1. Mean daily changes in HR in rat pups of different age.

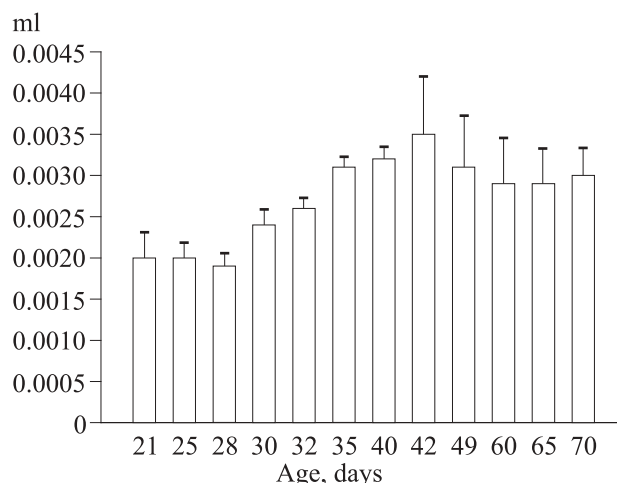


Fig. 2. Mean daily changes in SV in rat pups of different age.

relation was 0.9525-0.9687, which attests to strong effects of HR and SV on MBV ($p < 0.01$) at each stage.

Analysis of special coefficients, indicating the degree of each factor's effect on the resultative sign, showed that the correlation between MBV and SV was always high with a probability of $p < 0.01$. The lowest coefficient of correlation for SV ($r = 0.9087$) was observed in rats aged 42 days, while the mean daily increment of SV and MBV at this age was the maximum over the entire period of observation.

The correlation between HR and MBV during the first days of experiment was $r = 0.3646$ -0.6631 (mean relationship). A sharp increase was observed at the age of 35 days, after which the relationship between HR and MBV increased smoothly, the absolute HR values decreasing. Strong correlations were observed starting from the age of 40 days,

slightly decreasing by day 43. At the end of the experiment the correlation coefficients for HR—MBV and SV—MBV were virtually the same.

Hence, the mean daily changes in HR and SV during ontogeny are heterochronic.

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