Changes in Heart Rate of Rats Subjected to Treadmill Training

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 146, No. 11, pp. 570-572, November, 2008
Original article submitted December 3, 2007

The mechanisms of extracardiac regulation of heart rate were studied in rats subjected to muscle training on a treadmill with different slope angle (0°, 5.5° up, and 5.5° down). Muscle training on a treadmill sloping down was optimal for the development of training bradycardia in 70-day-old rats.

Key Words: *training bradycardia; heart rate; treadmill training; treadmill*

Mechanisms regulating the pumping function of the heart in laboratory animals were studied mainly during swimming [2-5,7,8]. The regularities of heart function and mechanisms regulating it in rats under conditions of running exercises are little studied, while running exercises on a track sloping up and down are used in muscle training for athletes of many specializations. We tried to simulate treadmill exercises with modification of the treadmill slope and studied the heart rates (HR) of rats subjected to treadmill training from day 42 to day 70 of life.

We studied the mechanisms of extracardiac regulation of HR in 42-70-day-old rats subjected to training on a treadmill with different sloping angle.

MATERIALS AND METHODS

Experiments were carried out on outbred albino rats (n=250) aged 42-70 days. The animals were kept under standard vivarium conditions with natural light and free access to water and food. The animals were divided into 4 groups at the age of 42 days: 1) controls; unlimited motor activity; 2) treadmill training at a 0° sloping of the track; 3) training on a treadmill sloping up at an angle of 5.5°; and 4) training on a treadmill sloping down at an angle of 5.5°. The duration of training was the same for animals of all groups.

Experiments were carried out using a TORNEO treadmill (Kettler). The rats were placed on the treadmill in special rectangular carcasses from organic glass. Due to this, 9 animals were trained simultaneously. Running exercises were started from the age of 42 days. The duration of training on day 1 was 1 min and daily increased by 1 min (Table 1). Hence, by the end of the week (day 7), the duration of training was 7 min. By the end of the training period (by the age of 70 days), the duration of training session was 28 min. The speed of treadmill moving was 5 m/min.

HR parameters were studied by tetrapolar impedance rheoplethysmography modified by R. A. Abzalov [1]. Volume and differentiated rheogram were

TABLE 1. Duration of Treadmill Training

Week day	Week 1	Week 2	Week 3	Week 4
Monday	1	8	15	22
Tuesday	2	9	16	23
Wednesday	3	10	17	24
Thursday	4	11	18	25
Friday	5	12	19	26
Saturday	6	13	20	27
Sunday	7	14	21	28

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0007-4888/08/1465-0633

recorded in rats narcotized with urethane (40 mg/kg intraperitoneally) during spontaneous respiration by means of an RPG-204 rheoplethysmograph developed and made at experimental production shops of the Russian Academy of Medical Sciences, and MacLab/4e (ADInstruments). The results were analyzed using Chart, Claris Works, and Igor Pro software. The data were statistically processed using common methods of variation statistics [6]. The significance of differences was evaluated using Student's *t* test.

In order to evaluate the extracardiac effects on HR, the drugs were injected through a catheter inserted in the femoral vein: obsidan (nonselective β-adrenoreceptor blocker; 0.8 mg/kg) and after 7 min atropine (muscarinic cholinoreceptor blocker; 0.6 mg/kg).

RESULTS

Heart rats values at rest before preparation were 440.69±9.31 bpm in 42-day-old control rats and 415.03±5.93 bpm in 70-day-old rats ($p<0.01$; Table 2). After 28 days of regular training, HR at rest before preparation was 347.64±3.69 bpm in group 2, 364.33±5.25 bpm in group 3, and 337.83±4.3 bpm in group 4. Heart rates in groups 2, 3, and 4 were significantly lower than in the controls. Hence, HR values at rest decreased after 28 days of training to a different degree, depending on the treadmill track sloping angle. Therefore, in group 4 70-day-old rats HR values were the lowest.

After preparation HR somewhat increased in all groups of rats aged 42 and 70 days, but these changes were insignificant ($p>0.05$). Injection of obsidian to 42-day-old controls caused a reduction of HR by 90 bpm in comparison with the initial values after preparation ($p<0.05$). In 70-day-old controls obsidan blockade led to HR reduction by 28 bpm ($p<0.05$). Atropine injection to 42-old rats led to HR increase (20 min postinjection) by 39 bpm in comparison with obsidan injection ($p<0.001$). In 70-day old rats atropine blockade led (after 20 min) to HR increase by 22 bpm ($p<0.05$). On the other hand, HR values of rats aged 42 and 70 days were lower 20 min after atropine injection than the initial values after preparation ($p<0.05$). Heart rate recorded 40 min after atropine injection was significantly higher in animals aged 42 and 70 days than initially before preparation ($p<0.01$).

Injection of obsidan to group 2 70-day-old rats decreased HR by 18 bpm in comparison with the value after preparation ($p<0.01$). In group 3 70-day-old rats, obsidan blockade led to HR reduction by 27 bpm ($p<0.01$). The difference in HR after preparation and obsidan injection in group 4 was 22 bpm ($p<0.05$). Atropine injection led to HR increase after 20 min in all groups of animals in comparison with the values after obsidan injection. The

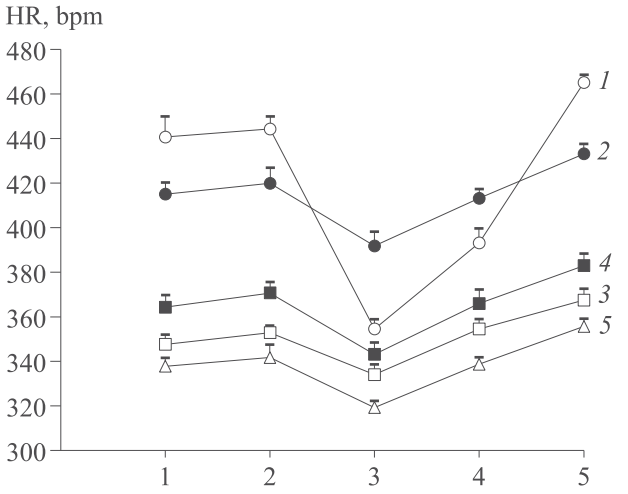

Fig. 1. Heart rates of 70-day-old rats subjected to treadmill training. *1*) control 42-day-old rats; *2*) control 70-day-old rats; *3*) group 2 70-day-old rats; *4*) group 3 70-day-old rats; *5*) group 4 70-day-old rats. Abscissa: week of training.

TABLE 2. Heart Rates of Rats Subjected to Treadmill Training (bpm)

Conditions of recording	Group 1		70-day-old rats		
	42-day-old rats	70-day-old rats	group 2	group 3	group 4
Initial before preparation	440.69±9.31	415.03±5.93^{+}	347.64±3.69^{+x}	364.33±5.25$^{+x\#}$	337.81±4.30^{+xo}
Initial after preparation	444.32±5.65	419.88±6.78^{+}	352.89±2.29^{+x}	370.70±4.45$^{+x\#}$	341.74±5.59^{+xo}
After obsidan injection	354.55±4.31*	391.76±6.20^{+*}	334.05±4.53^{+x*}	343.14±5.36^{x*}	319.25±2.15$^{+xo*\#}$
20 min after atropine injection	393.12±6.5*	413.15±4.05^{+*}	354.54±4.23^{+x*}	365.97±6.44^{+x*}	338.73±3.28$^{+xo*\#}$
40 min after atropine injection	465.17±3.28*	433.12±4.25^{+*}	367.53±5.20^{+x*}	382.91±5.40$^{+x*\#}$	355.70±3.24$^{+xo*\#}$

Note. $^{*}p<0.05$: significant differences between the status after injection of each of the drugs in comparison with control 42-day-old rats; $^{+}p<0.01$: significant difference between trained and intact rats from the age of 42 days in comparison with 70-day-old rats; $^{x}p<0.001$: significant differences between trained and intact rats aged 70 days; $^{\#}p<0.05$ compared to 70-day-old rats trained at a 0° sloping track (group 2); $^{o}p<0.01$ compared to group 3 70-day-old rats.

highest HR reaction was recorded in group 3 rats (22 bpm; $p<0.05$). Heart rates were still increasing 40 min after atropine injection in all groups of animals and were higher than the initial data before preparation.

Hence, regular muscle training of rats on a treadmill with different sloping angles starting from the age of 42 days until the age of 70 days caused the development of training bradycardia. Training bradycardia was more pronounced in 70-day-old rats subjected to treadmill training on the track sloping down. Heart rates of 70-day-old rats subjected to treadmill training on a track sloping down were lower after blockade of β-adrenoreceptors and muscarinic cholinoreceptors in comparison with animals of other experimental groups. Heart rate reactions of trained animals to obsidan and atropine were lower in comparison with heart rate reaction of intact 42-day-old animals to the same blockers. Hence, exercise on a treadmill sloping down is the optimal mode for the development of training bradycardia in 70-day-old rats in comparison with other treadmill exercises used in our experiments.

REFERENCES

1. R. A. Abzalov and F. G. Sitdikov, *Developing Heart and Motor Regimen* [in Russian], Kazan (1998).
2. R. A. Abzalov, *Evol. Fiziol. Biokhem.*, No. 5, 75 (1999).
3. N. I. Abzalov, *Ros. Fiziol. Zh.*, No. 12, 1580-1586 (2000).
4. I. Kh. Vakhitov and R. A. Abzalov, *Kazansk. Med. Zh.*, No. 5, 370 (1996).
5. A. I. Ziyatdinova and R. A. Abzalov, *Ros. Fiziol. Zh.*, No. 8, Pt. 2, 193-194 (2004).
6. G. F. Lakin, *Biometry* [in Russian], Moscow (1990).
7. R. R. Nigmatullina, *Byull. Eksp. Biol. Med.*, **127**, No. 6, 75 (1999).
8. I. G. Khuramshin, *Ros. Fiziol. Zh.*, No. 8, Pt. 2, 261 (2004).
9. A. S. Chinkin, *Motor Activity and Heart* [in Russian], Kazan (1995).