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Research Article

The Effects of Stress on the Vascular System for Different Ages in Rats

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Abstract

The effects of stress in newborns were more severe than adults, The changes in the blood vessels and the heart of age-related and the result of stress are reflected on adaptation and resistance to the development of cardiovascular disease, such as hypertension. Therefore, experiments were conducted to study the changes developments on the heart and blood vessels under the influence of stress at the stages of maturity, used a laboratory rat model. The impact of each of the chronotropic and the stress on the blood vessels at the newborn rats were higher than adult animals, myocardial indolence and high blood pressure were observed at the old rats compared to adult animals as a result of the stress-responses.

Keywords: cardiovascular system, stress, maturation, hypertension, blood vessels.

الخلاصة

الاجهاد يؤثر على حديثي الولادة بصورة اكبر مقارنة بالبالغين حيث ان التغيرات في الاوعية الدموية و القلب المرتبطة بالعمر ونتيجة للاجهاد تنعكس على التكيف ومقاومة تطور امراض الاوعية الدموية منها ضغط الدم. لذا اجريت تجارب لدراسة التغيرات الحاصلة على القلب و الاوعية الدموية تحت تاثير الاجهاد عند مراحل النضج ، استخدم فيها الجرذان)كنموذج مختبري. كان تاثير كل من الميقاتية chronotropic و الاجهاد على الاوعية الدموية عند الجرذان حديثة الولادة(اعلى من الحيوانات البالغة، كما لوحظ خمول في عضلة القلب و ارتفاع في ضغط الدم عند الحيوانات المتقدمة في السن مقارنة بالحيوانات البالغة نتيجة للاجهاد المسلط.

Introduction

In newborn rats, both vascular and chronotropic effects of stress are more pronounced and intense than in mature individuals which indicates, first uneconomic mode of functioning of the cardiovascular system (CVS) under stress in the early stages of maturation and secondly, improvement of cardiovascular adaptation mechanisms stress with advanced age. In old rats, the comparison of adult males detected myocardial refractory to stress amid which in turn increases the hypertensive reactions [9] [13]. It is seen as a manifestation of stress maladaptation CVS in the later stages of maturation.

In previous studies Berdnikova *et al.* 2012 showed changes in basal blood pressure (BP) in the maturation are associated with age-resistance to the development of arterial hypertension (AH), Increased blood pressure is observed in newborns and especially in aged rats compared with mature individuals [8] [12] combined with a reduced resistance to the development of hypertension indicating a narrow range of adaptive capabilities CVS in the early and late stages of maturation [11].

In particular, there is a suggestion that age-related changes in the cardiovascular stress reactivity are a direct reflection of resistance to the development of cardiovascular diseases, including arterial hypertension [3] [10]. It is important to note that researches in this area are extremely scarce and are mostly phenomenological no systematic study of the mechanisms, underlying age-related features of the cardiovascular sensitivity to stress and stability to the development of hypertension.

To solve this problem, experiments were conducted to study the cardiovascular changes in the maturation stress reactivity

Materials and Methodology

Study was carried out on 29 white male rats. Registration hemodynamic parameters - mean arterial pressure (AP) and heart rate (HR) in conscious rats were carried out on a computer system for direct detection of blood pressure in small animals (PowerLab / 400 ML 401, ID Instruments, 2002, Australia) with Chart 4 software, blood pressure sensors equipped (MLT0699, PowerLab, ID Instruments). For this, we implanted polyethylene catheter in one day before the experiments in the animals into the aorta through the left carotid artery branch under general nembutal anesthesia (0.40 mg / kg, ip). Cardiovascular stress reactivity was studied in infantile (n = 9, 6 weeks old, weight 50-70 g) and older (n = 10, 24-30-month age, weight 340-380 g) rats compared with mature individuals (n = 10, 5-7 months of age, 220-270 g) under 60-minute immobilization stress (by fixing the rats in wooden board in all limbs). Statistical analysis of experimental data was carried out with the help of Statistics Package 5.0 program. Differences were considered significant at $p < 0.05$. Data are presented as mean ± SEM.

Results and Discussion

The results showed that the infantile rats as compared to the mature individuals more sensitive to stress according to AP and HR. So, newborn rats were compared with mature individuals against the backdrop of higher basal AP values (122 ± 8 vs. 102 ± 2 mm Hg, $p < 0.05$) (Table.1).A significant increase was observed in this parameter during stress (Figure 1). Thus, the amplitude of the stress-induced hypertensive reactions in newborn rats was higher than that in mature males 1.4 times ($p < 0.05$).Here in rat hypertensive reaction was observed throughout the entire stress and within 60 min after cancellation, while a in mature animals AP significantly high values were recorded only in the first 15 min of stress, then this indicator gradually returned to basal values.

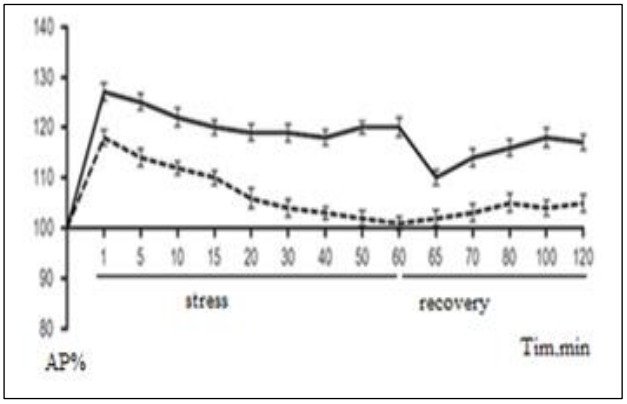

Figure 1: Changes in mean arterial pressure (AD%) at newborn (▬) and mature (▪▪▪) rats under stress and without stress (recovery)

The intensity of the chronotropic effects of stress were also more pronounced in newborn rats compared with mature individuals (23-33% against 7-21%, $p < 0,05$). However, heart rate was faster in newborn rats compared with mature animals (Figure 2). We observed that basal values of the heart rate did not differ between the values of newborn and mature rats (369 ± 8 and 381 ± 9 bpm. / min) (Table .1) . In mature rats CVS reaction was less severe than the stress amplitude (AP and heart rate) and duration (AP) compared with newborn individuals, indicating that less intensive and more economical mode of functioning of the CVS under stress in mature individuals in comparison with the newborn. Similar results were obtained in the observations of the students since it has been shown that high school students 12-16 years and chronotropic hypertensive reaction under stress of school were less pronounced, than in children of 7-8 years, which allowed the authors to concluded that improving cardiovascular adaptive mechanisms with age [7]. In old rats compared with mature individuals, there was a decline chronotropic and increased hypertensive effects of stress in spite of same basal values at heart old rats and adult males (398 ± 8 and 381 ± 9 bpm/min) (Table 1) in the first group, stressed animals are not accompanied by a significant increase in heart rate (Figure 3).

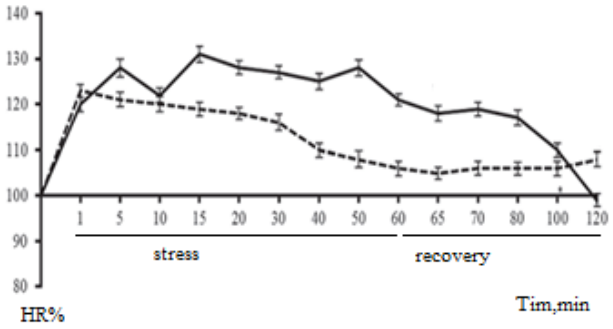

Figure 2: Changes in heart rate (HR%) at newborn (▬) and mature (▪▪▪) rats under stress and without stress (recovery).

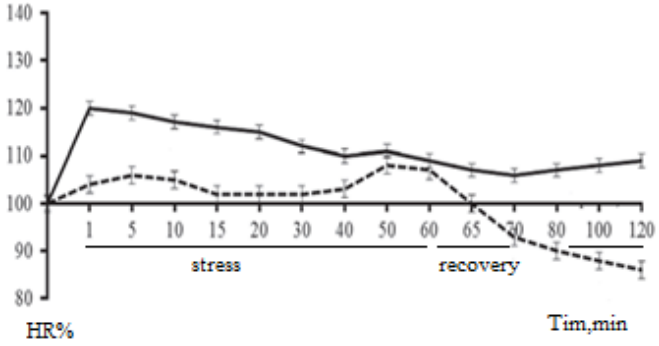

Figure 3: Changes in heart rate (HR%) in old (…) and mature (-) rats under stress and without stress (recovery).

In the recovery period in older individuals it was recorded even bradycardia. Against the background of the higher level AP alone in old animals compared with mature males (132 ± 4. vs. 102 ± 2 mm Hg. p <0,05) (Tab.1) when stressed at first observed more severe hypertensive reactions both in amplitude and duration than the second. Thus, the stress-induced increase in the amplitude of AP in old rats was greater than 1.5 times (p <0,05) mature rats. At the same time, recovery in older individuals was 2 times slower than in adult rats (Figure 4).

Decrease chronotropic reactivity to stress observed in the elderly [4] and is viewed by many authors as a reflection of general biological aging process [13] associated with reduced metabolic rate in all organs and tissues [2]. Increased vascular sensitivity to stress in the later stages of maturation reflects the age of reconstruction as the regulatory mechanisms [5] and morphological and functional properties of vessels [14] that expressed in decreased endothelium dependent vasorel-axation [6] and to increase the sensitivity of vascular vasoconstrictor factors [14].

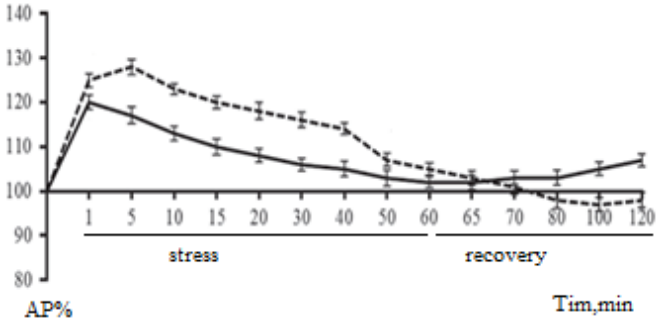

Figure 4: Changes in mean arterial pressure (AP%) in old (▪▪▪) and mature (▬) rats under stress and without stress (recovery).

Table 1: Mean ± SEM for Arterial hypertension and heart rate to all specimens

Type of specimens	Arterial hypertension mmHg	Heart rate bpm. / min
	mean ± SEM	mean ± SEM
Newborn rats	122 ± 8	369 ± 8
Mature rats	102 ± 2	381 ± 9
Old rats	132 ± 4	398 ± 8

Conclusions

In general, the results of the study showed that cardiovascular stress reactivity changes with advanced age. In infantile rats as vascular and chronotropic effects of stress are more intensity pronounced than that of mature individuals indicating that, at first, about uneconomic mode of functioning of the CVS under stress in the early stages of maturation, and secondly, the improvement of cardiovascular adaptation to stress mechanisms with age. In old rats compared to mature males refractory myocardial stress midst increasing hypertensive reactions was observed, and a

number of authors [9, 13] is considered as a manifestation of stress maladaptation CVS in the later stages of maturation. Thus, the study results chronotropic and vascular effects stress in rats of different ages suggest that cardiovascular stress reactivity is an indicator of CVS state which clearly reflect, the range of its adaptive capacity and, in particular, to the development of hypertension stability.

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References

[1] Berdnikova V.A., Kuznocova Ya.V., Kuznecova A.S. Vascular and chronotropic effects of stress in rats of both sexes and age. Bulletin experimental biology and medicine. No.1:13–17. 2012

[2] Clerico A., Fabio A. R., Passino C., Emdin M. Cardiac endocrine function is an essential component of the homeostatic regulation network: physiological and clinical implications. Am J Physiol Heart Circ Physiol 290: H17–H29, 2006

[3] Uchino B. N., Uno D., Holt-Lunstad J., Flinders J. B. Age-Related Differences in Cardiovascular Reactivity During Acute Psychological Stress in Men and Women. Journal of Gerontology: PSYCHOLOGICAL SCIENCES. 54B (6): 339-346. 1999

[4] Boutcher S.H., Stocker D.J. Cardiovascular response of young and older males to mental challenge. Journal of Gerontology. B51: 261–267. 1996

[5] Bulpitt C., Rajkumar C. Beckett N. Hypertension in the elderly Clinician's manual. Published by Science Press, London. 1005–1015. 1999

[6] Brandes R., Fleming I., Busse R. Endothelial aging .Cardiovascular Research. 66: 286–294. 2005

[7] Grinene E.Yu., Vaytkavichus V.Yu., Marchinskene E.Yu. The particularities of heart beat in students in school. Physiology of human.16 (1): 89–93.1990

[8] Godfrey K. M. and Barker D. JP. Fetal nutrition and adult disease.Am J Clin Nutr; 71(suppl):1344S–52S.2000

[9] Golbidi S., Frisbee J. C., Laher I. Chronic stress impacts the cardiovascular system: animal models and clinical outcomes. American Journal of Physiology - Heart and Circulatory Physiology. 308 No.12.2015

[10] Treiber F., Musante L., Kapuku G. Cardiovascular (CV) responsivity and recovery to acute stress and future CV functioning in youth with family histories of CV disease: a 4-year longitudinal study. International Psychophysiological Journal. 41: 65–74.2001

[11] Simon C. Langley-Evans Developmental programming of health and disease. Proc Nutr Soc. 65(1): 97–105. 2006

[12] WHO. Programming of chronic disease by impaired fetal nutrition Evidence and implications for policy and intervention strategies. 2002

[13] Uchino B., Birmingham W., Berg C. Are older adults less or more physiologically reactive? A meta-analysis of age-related differences in cardiovascular reactivity to laboratory tasks. The Journals of Gerontology: Physiological Science. 65(2): 154–162.2010

[14] Zicha J, Kune J. Ontogenetic aspects of hypertension development: analysis in the rat. Physiological Review.79: 1227–1282. 1999