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SEX RELATED PECULIARITIES OF THE ADRENAL TISSUE RESPONSE ON THE HYPOBARIC HYPOXIA AT THE ALTERED DURATION OF PHOTOPERIOD IN IMMATURE RATS

Key words: proteolysis, photoperiod, hypobaric hypoxia, adrenal glands, immature male and female rats.

Abstract. This study showed the sex related dependence of the reaction of proteolytic processes in tissues of the adrenal glands of male and female immature rats held in systemic intermittent hypobaric hypoxia and constant lighting. The modelling of hypobaric hypoxia combined with a varying length of the photoperiod (natural duration of photoperiod and constant lighting) causes a different changes of the proteolysis in the tissues of the adrenal glands of the male and female immature rats with varying intensity depending on the sex of animals and duration of photoperiod. Sex differences in the response of tissue proteolysis indicators in the main organ of adaptation process in immature animals indicate a genetic-dependent peculiarities of reactivity of the response mechanisms of the body on the action of environmental factors at their isolated and combined impact.

Introduction

Hypoxia is a condition in which the body as a whole (generalized hypoxia) or a region of the body (tissue hypoxia) is deprived of adequate oxygen supply. Hypoxia is one of the conditions of usual mode of life and, at the same time, growth factor levels of reactive oxygen species (ROS) [15]. Structural-functional change of the adrenal glands as regulatory organ of adaptive process is a typical manifestation of organic reaction to hypobaric hypoxia [14, 17]. The presence of polyorganic, morpho-functional disturbances, formed at participation of the neuro-endocrine system [8] and the manifestations of which depend on the age, sex and the presence of influence of other environmental factors is a peculiar feature for systemic adaptation to hypoxia [16]. Chronic hypoxia induces complex metabolic and endocrine adaptations [11]. Hypoxia results in decrease of energetic potential, macroergic phosphate and pyruvate dehydrogenase content [5]. The intensity of the response of organs and tissues of the body depends on the hypoxia level and sensitivity of the tissue to hypoxia [13, 18]. Possibility of the development of cross-adaptation according to hypoxia enables to use moderate hypoxic effects for the purpose hypoxic preconditioning of pathological changes caused by other factors [3, 9]. Hypobaric hypoxia influence upon expression of gene of sensitivity to hypoxia that may create protective effect under various pathologies [2]. A mild and non-damaging intermittent hypoxia is used intentionally during altitude training to develop an athletic performance adaptation at both the systemic and cellular level [3].

Melatonin is the main hormone of the pineal gland of the brain, which not only synchronizes the rhythms of peripheral tissues but also has anti-stress and antioxidant defenses and provides the body adapt to the dangerous effects of the environment, including hypoxia [4], and it has a significant effect on the reproductive system [7].

The nature of proteolytic activity in peripheral tissues changes in the process of reaction to a variety of environmental factors, what may be both a manifestation of regenerative processes, and their involvement in the mechanisms of apoptosis [6, 12].

Sexual dependence of the reaction of proteolytic activity in the adrenal glands tissues under conditions of hypoxic preconditioning of effects of the altered regime of illumination in immature female rats remain not studied.

The aim of the research

To study the sex related dependence of reaction of proteolytic processes in the tissues of the adrenal glands in immature rats under ordinary conditions of holding and hypoxic conditioning by systemic intermittent hypobaric hypoxia of changes, caused by permanent lighting.

Material and methods

Experiments were carried out on 36 male and 40 female immature white laboratory rats aged 1 month with an average body weight of 0,052 kg. Hypobaric hypoxia was created in the flowing respiratory chamber by means rarefaction of air till the value corresponding to a height of 4000 m above sea level

with "lifting" velocity 0.4 km / min [10]. Under hypoxic conditions the animals were held for 2 hours daily during 14 days (group 2, 4). The changes of photoperiod duration were modeled by permanent day-and-night lighting (500 lux light intensity) a model of decreasing of melatonin-producing function of the pineal gland (group 3, 4). Photoperiod changes were introduced on day before hypoxic exposure. Animals of group 4 were held at simultaneous action of hypobaric hypoxia and constant lighting. Intact rats (group 1) were held under conditions of natural light and normal atmospheric pressure, were used as control ones.

The following day after the completion of experimental influence all animals were decapitated under slight diethyl ether narcosis. The tissues of the adrenal glands was taken out on cold immediately after the decapitation and the weighted samples were homogenized in 2.0 ml of cooled borate buffer (pH 9.0). The homogenate was used in biochemical analysis. Proteolytic activity was determined according azoalbumin, azokazein and azokol lysis [1].

Statistical analysis of the results was performed by the method of variational statistics using Student's test.

Experiments have been carried out in compliance with the European Convention for the Protection of Vertebrate Animals used for Experimental and Other Scientific Purposes (Strasbourg, 1986).

Discussion of the Results

Modeling of chronic hypobaric hypoxia under conditions of natural light in immature female rats resulted in a significant restructuring of the nature of the processes of proteolysis in the tissue of the adrenal glands (Table). In particular, lysis of low molecular weight proteins (LMWP) in the tissue of the adrenal glands decreased by 29% in comparison with the control, lysis of high molecular weight proteins (HMWP) - by 27,9%. Lysis of collagen mostly decreased the - by 43,5% compared with the group that was under conditions of normoxia. In adrenal glands of immature male rats hypobaric hypoxia had not probable effect on proteolysis under conditions of natural light

Processes of proteolysis in the tissues of the adrenal glands of females were undergone of opposite changes by application of constant light. Thus, LMWP lysis increased by 13,4%, lysis of azokazein - by 14,4%, in comparison with the control one, and only lysis of collagen underwent tendencies to decrease. More intensive increasing we observed in males. Thus, respectively LMWP lysis increased by 39,7%, lysis of HMWP and collagen lysis - by 1,7 times.

Simultaneous action of hypobaric hypoxia and constant lighting led to increase of proteolysis indices concerning all kinds of protein molecules: LMWP

Table

Reaction of proteolytic process in the adrenal glands tissues of immature rats under conditions of hypobaric hypoxia and modified duration of photoperiod (M±m)

№ of group	Conditions of research	Sex	Lysis of LMWP, мкг азоalbumin/1g of tissue per 1 hour	Lysis of HMWP, мкг азоказеїн/1g of tissue per 1hour	Lysis of collagen, мкг азокол/1g of tissue per 1hour
1	Natural lighting, normoxia,	male, n=8	83,94±3,26	65,97±4,077	7,567±0,512
		female, n=10	115,9±3,901	104,6±5,317	12,42±1,722
		p	0,000	0,000	0,014
2	Natural lighting, hypoxia,	male, n=9	82,15±6,400	75,458±5,287	7,022±0,704
		female, n=10	76,06±4,90	63,30±4,59	7,72±0,536
		p	0,230	0,050	0,220
3	Permanent lighting, normoxia,	male, n=10	117,3±15,24	114,7±16,2	13,21±2,14
		female, n=10	131,4±4,238	119,7±6,679	11,46±0,666
		p	0,200	0,390	0,227
5	Permanent lighting, hypoxia	male, n=9	115,7±8,33	105,9±9,97	8,29±0,826
		female, n=10	145,1±5,864	134,7±6,030	13,27±1,087
		p	0,006	0,015	0,001

Note: p – criterion of probability of difference in comparing of male and female groups under same experimental conditions.

lysis increased by 25% in female and by 37,8 % in male, lysis of HMWP increased by 28% in female and by 60,5 % in male, comparing with the control one. Accordingly, simultaneous action of hypobaric hypoxia permanent lighting caused the most of all experimental groups increase the intensity of proteolysis, particularly in regard to macromolecular proteins. At the same time, lysis of collagen remained insignificantly higher in comparison with the control one and substantive hypoxia.

The detected peculiarities of the reaction of the tissues proteolysis indices in the adrenal glands in immature rats to the applied factors and their combinations indicate sex related dependence of the sensitivity of the immature rats to the separated action of medium non-damaging intensity of environmental factors and different intensity of the process of adaptation under various conditions, and equalization of reaction of male and female immature animals both to the simultaneous action of influences.

Conclusions

1. A sex dependent difference in the activity of proteolytic processes in the adrenal glands in immature rats was found. In intact male rats intensity of proteolysis is significantly lower than in female rats.

2. Modeling of the decreased melatonin-producing function of the pineal gland by application of constant lighting resulted in significant increase of the activity of proteolytic processes in the tissues of the adrenal glands in both male and female immature rats, that may testify to intensification of elimination of oxidation-modified protein molecules, formed by reducing of tissues antioxidant capacity according to melatonin deficiency. Simultaneous action of hypobaric hypoxia permanent lighting caused the most of all experimental groups increase the intensity of proteolysis, particularly in regard to macromolecular proteins.

3. The reaction of the tissues proteolysis indices in the adrenal glands in immature rats on the applied factors and their combinations indicates sex related dependence of the sensitivity of the immature rats to the separated action of non-damaging intensity of environmental factors, and equalization of reaction of male and female immature animals both to the critical simultaneous action of influences.

Perspectives of the research

The sex related dependence of mechanisms of reaction of proteolytic processes in their interaction with the processes of peroxidation of proteins and their role in adaptive restructuring of the adrenal glands tissues under conditions of hypoxic preconditioning of the damaging effects of the modified

duration of photoperiod by using of moderate hypobaric hypoxia require further investigation and comprehensive analysis.

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**СТАТЕВІ ОСОБЛИВОСТІ РЕАГУВАННЯ ТКАНИН
НАДНИРКОВИХ ЗАЛОЗ СТАТЕВОНЕЗРІЛИХ ЩУРІВ
НА ДІЮ ГІПОБАРИЧНОЇ ГІПОКСІЇ ЗА ЗМІНЕНОЇ
ТРИВАЛОСТІ ФОТОПЕРІОДУ**

О.В. Ясінська

Резюме. Дослідження показало статеві особливості реакції протеолітичних процесів в тканинах надниркових залоз статевонезрілих самців і самиць щурів, за дії системної переривчастої гипобаричної гіпоксії та постійного освітлення. Моделювання гипобаричної гіпоксії в поєднанні з різною тривалістю фотоперіоду (природним та постійним освітленням) викликає зміни протеолізу різної інтенсивності в тканинах надниркових залоз статевонезрілих самців і самиць щурів залежно від статі тварин і тривалості фотоперіоду. Статеві відмінності в реакції показників тканиного протеолізу в ключовому органі адаптаційного процесу в незрілих тварин вказують на генетичну природу статевих особливостей реактивності механізмів реагування організму на дію факторів зовнішнього середовища при їх ізольованому та комбінованому впливі.

Ключові слова: тканинний протеоліз, фотоперіод, гипобарична гіпоксія, надниркові залози, статевонезрілі самці та самиці щурів.

**ПОЛОВЫЕ ОСОБЕННОСТИ РЕАГИРОВАНИЯ
ТКАНЕЙ НАДПОЧЕЧНИКОВ НЕПОЛОВОЗРЕЛЫХ
КРЫС НА ДЕЙСТВИЕ ГИПОБАРИЧЕСКОЙ
ГИПОКСИИ В УСЛОВИЯХ ИЗМЕНЕННОЙ
ДЛИТЕЛЬНОСТИ ФОТОПЕРИОДА**

Е.В. Ясинская

Резюме. В результате исследования продемонстрированы половые особенности реакции протеолитических процессов в тканях надпочечников самцов и самок неполовозрелых крыс под влиянием системной прерывистой гипобарической гипоксии и постоянного освещения. Моделирование гипобарической гипоксии в сочетании с различной длительностью фотопериода (естественным и постоянным освещением) вызывает изменения протеолиза в тканях надпочечников неполовозрелых самцов и самок крыс с различной интенсивностью в зависимости от пола животных и продолжительности фотопериода. Половые различия в реакции показателей тканевого протеолиза в ведущем органе процесса адаптации у неполовозрелых животных указывают на генетически обусловленные половые особенности реактивности механизмов реагирования организма на действие факторов окружающей среды при их изолированном и комбинированном воздействии.

Ключевые слова: тканевой протеолиз, фотопериод, гипобарическая гипоксия, надпочечники, неполовозрелые самцы и самки крыс.

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