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Reactions of Some Endocrine Glands in Male Infant Rats to Acute Hypoxia at the Second Stage of Sexual Maturation

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Abstract

The experiment demonstrated that at the single 20-minute hypoxia of relatively severe form (85% N₂ +15% O₂) the hormonal reactions from the suprarenal cortex, thyroid gland and testicles in the male infant rats in the age of 2 months at the middle stage of sexual maturation are ambiguous. The adrenocortical hormone (cortisone) in the blood plasma increases at the very first day of hypoxia, and then the reaction dies out. On the 3rd day of experiment the blood level of thyroid gland hormone (thyroxine) increases slightly, and the total testosterone (hormone of testicles and suprarenal cortex) remains within the reference values, and to the 5th day of experiment it decreases substantially in relation to the standard.

For the body of human and animals, especially in the early periods of postnatal ontogenesis, the events of acute oxygen deficiency (O₂) (hypoxia) is a life-threatening factor resulting sometimes in its death.

According to the literature, the impact of hypoxia causes in the cells and tissues of body the complex, reversible and irreversible changes both of specific and common nature, and many post-hypoxic changes have either adaptive or pathological orientation (Michels C., 2004). Herewith, the mitochondrial biochemical cycles of oxidative phosphorylation which shall provide the body with the sufficient quantity of free energy (ATP) are violated in the course of early (primary) reactions (Lukyanova, L.D., 2001). And the ATP deficit affects negatively the excitability and activity of brain neurons, muscle and gland cells (Samoylov M.O., 1985). Herewith, also the synthesis of a number of functionally important neuropeptides, mediators and hormones (Mishra O.P., Delhoriya M., 1999; Chen X., 2000), conjugation of systemic nervous and neuroendocrine regulation mechanism as well as the performance of a number of cognitive and behavioral functions are violated (Mehbaliyeva E.J., 2014).

The reactions of the vegetative nervous system and especially its central link (hypothalamus) occupy the important place in the development of the secondary (late) post-hypoxic effects. It was demonstrated that the hormonal activity of hypothalamic neurosecretory cells and those endocrine glands the functional activity of which is controlled by the neurotropic hormones changes ambiguously in case of hypoxia (Herman R. E. et al., 1994).

However, regardless of great success in the development and assessment of the issues of hypoxia a number of aspects of this research direction are currently under- investigated (Mehbaliyeva E.J., 2013). In this regard, in this work the research was aimed at studying the changes in the secretory activity of such important peripheral endocrine glands as suprarenal cortex, thyroid gland and testicles in the male infant rats experimentally affected by hypoxia which were at the second medium stage of sexual maturation.

1. Methods of Research

The work was performed with 16 white Wistar male infant rats in the age of twomonths. The animals were subdivided into the reference and experimental groups

(8 animals in each group). The animals for the experiment were one by one affected by the single hypoxia during 20 minutes in the small-volume special chamber using the following composition: nitrogen (N₂) 85% and oxygen (O₂) 15%. In order to neutralize

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the additional negative impact of CO₂ exhaled by the animals the certain amount of chemical absorber Na₂O₂ was placed into the chamber in advance.

The blood was taken systematically from the femoral vein from each reference and tested animal. Bioethically, for the work with experimental animals, it is the minimally invasive method allowing at the same time for tracing the changes in the blood of the investigated indicator in the same animal during the whole period of experiments. The content of cortisone (hormone of suprarenal cortex), thyroxine (hormone of thyroid gland) and total testosterone (hormone of suprarenal cortex and testicles, androgen glands) was studied in the blood plasma of the reference and experimental infant rats. The determination of hormones in the experimental rats was performed on the 1, 3 and 5 day of hypoxia.

The determination was carried out using the method of enzyme-linked immunoelectrodiffusion assay (Wild D., 1994). Herewith, the reagent kits Siemens ADVIA CENTAUR Cp., Lite Reaktifi were used. Each hormone was studied in the separate plasma sample using the special kit. The concentrations of hormones were measured using the automatic analyzer. All the tests were performed in the Central Biochemical Laboratory at the Azerbaijan Medical University under the scientific cooperation agreement. The obtained data are processed statistically using the Student- Fisher criterion. The differences were considered as credible at $p < 0.05$ and lower.

2. Results of Research

Because in the course of research we studied the content of different hormones in the blood of sexually immature infant rats, the assessment of functional activity in this age of those endocrine glands which produce them in the body of these animals was very important for us. It was found that in the normally growing (intact) male infant rats in the age of two months the blood has different amounts of hormones: the content of adrenocortical hormone (cortisone) in the blood plasma was, according to our data, 2.7 mg/dl, hormone of thyroid gland (thyroxine) – 2.6 mg/dl, and total testosterone (hormone of testicles and suprarenal cortex) – 21.0 mg/dl.

It is known that cortisone (or hydrocortisone) participates in the regulation of many cellular processes, in the carbohydrate, protein and fat (lipide)

metabolism, stimulates the decomposing of sugars and proteins, activates the formation of glycogen in liver through the acceleration of glucogenic amino acids deamination and conversion of their nitrogen-free residues to glucose, strengthens the protective and adaptive body potency and is a “stress” hormone. Thyroxine increases the intensity of the intracellular oxidative reactions, stimulates the growth and development of body, supports the excitability of the nervous and muscle cells and participates in stresses. And testosterone activates the functions of male reproductive organs and sexual behavior, affects the total metabolism, stimulates the synthesis of proteins and belongs to strong anabolic hormones (Whitli R.I., et al., 1999; Ugryumov M.V., 1999; Dedov I.M. et al., 2000).

According to literature data, in the immature animals the blood level of a number of hormones, especially those the intensity of production and excretion of which is regulated through the tropic functions (functions of adrenocorticotrophic hormone, thyroid stimulating hormone and follicle-stimulating hormone) of pituitary- hypothalamic system is usually lower than in mature animals. It is commonly known that the hormones studied by us are produced in the relevant glands controlled by this system and our data also confirm the stated above. As it was said already, comparatively low levels of cortisone and thyroxine and the higher values of testosterone are detected in the blood of male baby rats in the age of two months at the medium stage of sexual maturation.

The hormonal reactions for hypoxia in the same infant rats are characterized by some peculiarities. Figure 1 shows the curves of dynamics for changes in the concentrations of cortisone, thyroxine and total testosterone during the early stage of exposure to acute hypoxia. It was detected that the impact of hypoxia is ambiguous for the functional activity of suprarenal cortex, thyroid gland and testicles that actually is reflected in the dynamics of the quantitative change of their hormones in the peripheral blood. Moreover, the cortisone content value first increases sharply and then it decreases gradually to the 5th day of the experiment. Thyroxine increases only on the 3rd day of hypoxia, and changes in the testosterone level in the course of the experiment are of other nature: first, it decreases sharply, then it increases and decreases again, compared to the reference.

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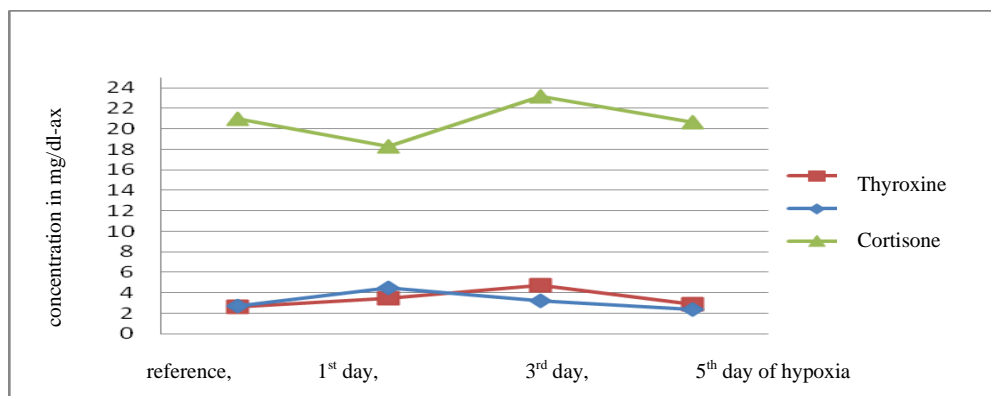


Fig. 1. Curves of change in the concentration of cortisone, thyroxine and testosterone in the blood plasma of male infant rats in the age of two months before and after of acute hypoxia

The literature contains the data that even the prenatal hypoxia can change the levels of corticosterone and testosterone in the early postnatal period of ontogenesis (Herman R.E. et al., 1994). We also demonstrated that the sex hormones (estradiol and testosterone) are susceptible to decrease after hypoxia in the experimental animals (infant rats and baby rabbits) in the age of one and three months (Mehbaliyeva E.C., 2015).

From the conducted experiment it can be concluded that the endocrine glands are involved into the reaction to hypoxia depending on their physiological role in the body of animal starting the sexual maturation cycle. In this case the quick reaction to hypoxia was observed for the adrenocortical gland producing the so-called “stress” hormones which include also the cortisone. It appears that the thyroid gland little later is included into the system of post-hypoxic reactions; and herewith the reproductive glands are inhibited to some extent in the functional relation.

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