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Influence of intermittent hypoxia exposure on the quality of adaptive reactions

Wpływ ekspozycji na przerywaną hipoksję na jakość reakcji adaptacyjnej

INTRODUCTION

A number of studies have investigated the performance of adaptive reactions in response to specific and nonspecific stress factors. Intermittent hypoxia exposure has been studied extensively as a nonspecific stress trigger with the purpose of experimental and clinical medicine [1,6]. Recent studies have demonstrated that short-term daily intermittent altitude exposure was equally as effective as continuous altitude residence in inducing physiological adaptations consistent with altitude acclimatization. Although the positive benefits of intermittent hypoxic training (IHT) have been clearly defined, the potential negative consequences of IHT on health, specifically the immune system, remain undefined [5,7]. Thus, taking it into consideration, it was related to the changes, elicited by hypoxia exposure to hematological indices. Changes of blood parameters under given circumstances could determine the development of nonspecific adaptive response.

MATERIAL AND METHODS

The experiments were carried out on intact male rats (weight 180–220 g, control and experimental group). The experimental group was exposed to 10-days of IHT. The scheme was as follows: during three days of hypoxic training, it was gradually decreased in oxygen content in inhaled air: the 1-st day – to 18.5%, 2-nd day – 16.4%, 3-rd day – 14.5% all resting days. The oxygen partial pressure under created conditions was equal to 110 mmHg in atmospheric air, oxygen partial tension – 64 mmHg in arterial blood respectively, and oxygen hemoglobin saturation – nearly 88%. Then, the hematological parameters were analyzed such as red blood cells counts, hematocrit, hemoglobin content, leucocyte counts, number of monocytes and lymphocyte, polimorphonuclear neutrophils and eosinophils counts. The adaptation index (IA) was calculated by dividing the lymphocytes counts to polimorphonuclear neutrophils counts. Some others hematological coefficients like GAI, LGI, NLRI, LMRI were also taken into account.

RESULTS

The effects of 10-days' exposure to hypoxia in experimental rats is considered to be related to an increased production of red blood cells (6.3%) (Fig. 1), increase in (6%), resulting in an increased oxygen carrying capacity of the blood and oxygen utilization. Changes in leucocyte profile were observed as well. The white blood cell response altitude is characterized by the decrease in leucocyte counts followed by an increase in monocytes and lymphocytes counts, and at the same time a decrease in polimorphonuclear neutrophils as well as eosinophils counts (Fig. 2). Adaptation index was increased by 32.4% compared to control group (Fig. 3).

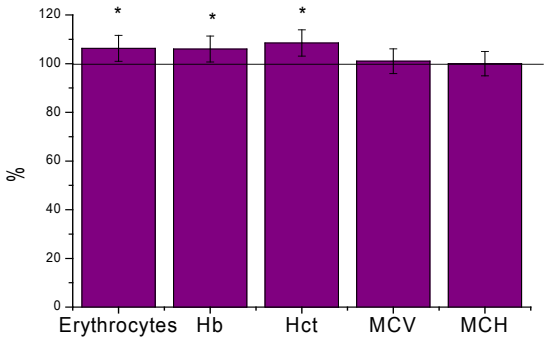

Fig. 1. Peripheral blood state changes under condition of intermittent hypoxia in comparison with control (100 %), * Significance ($p < 0.05$) is in relation to control

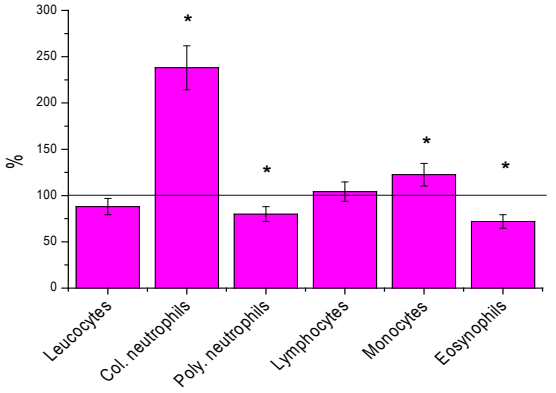

Fig. 2. Changes in leucocytes types' content under condition of intermittent hypoxia in comparison with control (100 %) * Significance ($p < 0.05$) is in relation to control

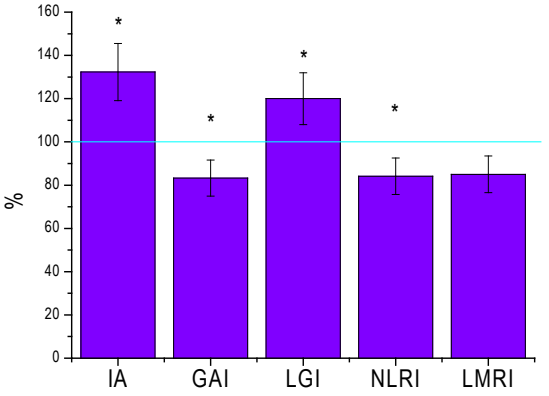

Fig. 3. The hematological indices change under intermittent hypoxia in comparison with control (100%)

* Significance ($p < 0.05$) is in relation to control

DISCUSSION

10-days' intermittent hypoxia exposure affects erythropoiesis, resulting in a moderate increase in red blood cells count and hemoglobin content. Most obviously, IHT causes the production of hypoxia inducible factors. Hypoxia increases lung ventilation leading to hypocapnia. Both hypoxia and hypocapnia have a positive effect on tissue supply, for they simplify oxygen dissociation from oxyhemoglobin. The probable explanation of these hematological changes could be related with decreased O2 delivery to kidney, which subsequently causes increased secretion of erythropoietin responsible for control of erythropoiesis.

According to the well-known criteria proposed by Radchenko O.M. the data observed under condition of IHT (decreased in leucocyte count, combined with increase in IA) most probably are involved in the development of general nonspecific adaptive response, evaluated as a reaction of increased activation [8]. Such type of response is generally characterized by most effective mobilization of protective and regulatory system of body organism.

According to recent scientific research, the reaction of increased activation is supported by morphological changes – hypertrophy of thymus medullary zone, hyperplasia of reticuloendothelial cells of the lymphatic nodes [2,4]. It would probably be explained by physiological stimulation of the lymphatic-node system. Under proper conditions, according to the literature, the secretion of all tropic hormones is enhanced. In addition to this, such kind of adaptive response is associated with the predominantly anabolic profile of metabolism. High efficiency of energy utilization and expenditure has also been suggested. It is important to underline that in the morphological research of adrenal cortex, the endocrine gland participates in antistress response. Therefore, the hypertrophy of zona glomerulosa generally associated with the reaction of increased activation is considered to be the

reason for hyperproduction of mineralocorticoids, followed by increased body resistance and mild antistress effect [3].

CONCLUSIONS

These findings suggest that intermittent hypoxic training in experimental rats improve the efficiency of adaptive reactions and nonspecific body resistance. Such type of adaptive reaction, according to the recent literature, was qualified as increased activation, which is associated with the mobilization of protective stresslimiting mechanisms.

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SUMMARY

The effects of 10-days' exposure to hypoxia in experimental rats is related to stimulation of erythropoiesis and changes in leucocytes response. Changes in leucocyte profile at altitude are followed by a decrease in leucocytes counts associated with an increase in monocytes and lymphocytes counts, and at the same time a decrease in polimorphonuclear neutrophils as well as eosinophils count. The observed type of adaptive reaction is qualified as increased activation, associated with mobilization of protective stress-limiting mechanisms.

Key words: adaptive reactions, intermittent hypoxia exposure, hematological indices, leucocytes count, adaptation index

STRESZCZENIE

Wpływ 10-dniowej ekspozycji na niedotlenienie u szczurów doświadczalnych jest uzależniony od stymulacji erytropoezy i zmian w odpowiedzi leukocytarnej. Zmiany w profilu leukocytarnym na dużych wysokościach poprzedzają spadek liczby leukocytów, związany ze wzrostem liczby monocytów i limfocytów i jednoczesny spadek liczby neutrofili wielojądrzastych i eozynofili. Obserwowany typ reakcji adaptacyjnej jest kwalifikowany jako wzrost aktywacji, związany z mobilizacją ochronnych mechanizmów ograniczających stres.

Słowa kluczowe: reakcja adaptacyjna, ekspozycja na przerywaną hipoksję, wskaźniki hematologiczne, liczba leukocytów, wskaźnik adaptacji