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METHODS OF TRAINING AIMED AT ELIMINATING TISSUE HYPOXIA

METODY TRENINGOWE ELIMINACJI HIPOKSJI TKANKOWEJ

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A – przygotowanie projektu badania | study design, **B –** zbieranie danych | data collection, **C –** analiza statystyczna | statistical analysis, **D –** interpretacja danych | interpretation of data, **E –** przygotowanie maszynopisu | manuscript preparation, **F –** opracowanie piśmiennictwa | literature review, **G –** pozyskanie funduszy | sourcing of funding

SUMMARY

Chronic hypoxia is a common condition affecting the organ tissues and systems in the human body. Tissue hypoxia affects cell function, leading to cell damage and death, and may be the cause of many chronic diseases that are generally perceived as civilization diseases. The problem of eliminating or mediating the symptoms of hypoxia involves searching for a physiological mechanism that can prevent its development.

To maintain gas homeostasis in the blood, it is necessary to adjust the function of the respiratory system, which can only be achieved by special breathing training. The aim of this paper was to investigate the training methods directed at producing physiological hypercapnia as means of eliminating tissue hypoxia and to examine the existing methods of using physical exercise to obtain physiological hypercapnia. The simulation method of obtaining physiological hypercapnia is an alternative to the existing training methods aimed at eliminating tissue hypoxia. The human body requires a regular overdose of carbon dioxide (hypercapnia) to maintain physiological norms. Daily training allows the breathing, and consequently the blood CO_2 levels, to return to the normal.

KEYWORDS: hypercapnia, breathing training, hypoxia

STRESZCZENIE

Przewlekłe niedotlenienie komórek to częsty stan, w którym przebywają komórki narządów i układów organizmu człowieka współczesnego. Niedotlenienie prowadzi do niezgodności funkcjonowania organizmu, uszkodzenia tkanek, a nawet do śmierci. To niedotlenienie jest podstawą, a w rzeczywistości przyczyną wielu chorób przewlekłych, postrzeganych jako choroby cywilizacyjne. Problem wyeliminowania lub zmniejszenia objawów niedotlenienia determinuje konieczność znalezienia środków i fizjologicznego mechanizmu, który może zapobiegać rozwojowi tego stanu.

W celu utrzymania homeostazy gazowej konieczne jest dostosowanie funkcjonalności systemu oddechowego. To można osiągnąć jedynie przez specjalny trening oddechowy. Celem pracy była inspektyza metodologii treningowej (imitacyjnej) wytwarzania hiperkapnii fizjologicznej jako środka eliminacji hipoksji. Metoda imitacyjna jest alternatywą dla istniejących środków treningowych wytwarzania hipoksji. Organizm człowieka wymaga regularnego przedawkowania dwutlenku węgla (hiperkapnia) dla utrzymania jego fizjologicznej normy. Codzienne treningi prowadzą oddychanie, a w tym i poziom CO_2 we krwi, do normy.

SŁOWA KLUCZOWE: hiperkapnia, trening oddechowy, hipoksja

Background

Hypoxia and carbon dioxide

Chronic hypoxia or oxygen starvation is a common condition affecting the tissues and systems of human organs. Tissue hypoxia affects cell function, leading to damage and death of the cell, and may be the cause of many chronic diseases that are generally perceived as inevitable diseases of age [1]. The symptoms of organ diseases appear when acute hypoxia is caused by a sequence of stresses. When brain structures are affected by acute hypoxia, instantaneous death may occur [2–3].

Research has shown that tissue cells can receive as little as 50% of the required dose of oxygen as a result of stress, as little as 15–20% due to environmental impacts, as little as 30% during exercise, and as little as 10% when rest [4–5]. In the elderly, this can be compounded by age-related pulmonary failure, resulting in premature aging, decreased energy, and numerous diseases.

In 1911, PM Albitsky found that metabolic carbon dioxide (CO_2), formed from the oxidation of nutrients, is partially released to the environment through the lungs. Some metabolic CO_2 is permanently retained in the body due to biological necessity. The CO_2 content of arterial blood is the most important indicator of homeostasis. Four parameters depend directly on the level of CO_2:

– vascular and bronchial tone;

– number of open capillaries;

– the degree of deoxygenation of oxyhemoglobin – i.e., the absorption of oxygen by the cells;

– the capacity of the buffer blood system [6].

The problem of eliminating or ameliorating the effects of hypoxia involves the search for a physiological mechanism that can act to prevent its development.

Methods of eliminating tissue hypoxia

The physiology of the human body is such that the level of CO_2 rises naturally during exercises, such as walking or running. Physiologists refer to this condition as "physiological hypercapnia".

What are the direct physiological consequences of hypercapnia? It is known that, at maximum physiological hypercapnia (such as arises from an aerobic burden equivalent to running about 10 km in an hour), there are 30 times more capillaries in an expanded state than in the absence of physiological hypercapnia; the level of oxyhemoglobin (where O_2 binds with hemoglobin) increases by a factor of 2–3; the arteriovenous difference in oxygen increases by a factor of 3–4 [2, 7].

There is another method that can also be referred to as "physiological hypercapnia". For five thousand years, Indian yogis have effectively used a training method for voluntary control of the breath to obtain a minimum respiratory minute volume (RMV) [8–9]. It was only in the twentieth century that, based on scientific discoveries of the Russian physiologists Albitsky and BF Verigo the increased appreciation of the fundamental role of carbon dioxide (CO_2) in the regulation of the mechanism of oxygen absorption (O_2) in the human body, KP Buteyko discovered the mechanism underlying the yogic practice and explained the therapeutic effect of reducing pulmonary ventilation at rest [4, 10]. This method lead to a practical application in the form of the first scientifically based technological hypercapnic breathing exercise.

Referred to as the method of volitional elimination of deep breathing (MVEDB), it is based on yogic exercises that aim for the arbitrary control of breathing through breath retention following exhalation and increasing the duration of the exhalation. As a result, the volume of breathing is reduced to the necessary minimum, reducing the normal physiological value of CO_2 concentration in the blood. The hypoxic syndrome was thus eliminated, leading to recovery. Yet despite the recognition and popularity enjoyed by Buteyko's method, it has not become widespread, as the exercises require willpower and a certain time investment. However, the possibility of eliminating of the underlying cause of health disorders (tissue hypoxia) by normalizing blood gas composition, as suggested by Buteyko, has contributed to the search for new means to generate this process in the human body.

A natural decrease in the intensity of external respiration mediated by the adaptation of the respiratory center is caused by regularly recurring physiological hypercapnia of sufficient intensity. This expresses itself as a decrease in the respiratory minute volume (RMV) among runners, athletes, yogis, and practitioners of Buteyko's method over time, reaching rest values of 2 liters per minute among advanced Indian yogis, 4.5 liters per minute among runners and athletes, and 4–5 liters per minute among users of Buteyko's method [11].

This natural reduction in RMV leads to the optimal containment of CO_2 in the body and provides a constant biological basis for normal metabolism due to the normalization of oxygen supplied for tissue cells at rest.

In this way, due to physiological hypercapnia, the normal functioning of the body both in motion and at rest is enabled. Therefore, the regular creation of a state of "physiological hypercapnia" is a necessary condition of normal physiology and its preservation for many years. There is need for long-term, daily, high-level physiological hypercapnia in order to successfully process restoring normal physiology and achieve a high level of health, which allows the RMV to be reduced gradually.

Simulation training

In 1998, on the basis of fundamental scientific knowledge of human nature, a practical and affordable way to create physiological hypercapnia was found (Russian Federation patent no. 2000117766 and international patent no. RTS/K1G/00260 by NA Agadjanyan, YN Mishustin, and SF Levkin) [11]. This

solution, marketed as the Samozdrav device, does not require great willpower or extensive physical effort from the user; it instead involves one or two 20-minute sessions per day of quiet breathing through a hypercapnicator device containing a special gas mixture; this is referred to as a "sports simulator". Most typically within four to ten months, an automatic normalization of the average daily level of CO_2 occurs thanks to a reduction in the RMV. This leads to a gradual restoration in cells' need for oxygen and in return of the energy levels of billions of cells to normal values, as well as a normalization of metabolism, and a fundamental self-recovery of the body that reduces the likelihood diseases of civilization.

The breathing of this mixture prevents the excretion of CO_2, which is formed continuously in the body, and leads to physiological hypercapnia just as during walking or running. After some time, its level in the arterial blood gradually increases, better supplying organ cells and systems with oxygen. During the session, a significant increase in the amount of oxygen supplied under physiological hypercapnia restores energy production in cells and restores normal metabolism; a result, there is an increasing in the production of CO_2, which is released into the blood, creating positive feedback.

The increased CO_2 blood level during the session lasts for several hours as a consequence of the intensified metabolism, and has a training effect on the respiratory center. Such hypercapnic training over several months gradually leads to normal breathing becoming less deep and more superficial. The pulmonary ventilation decreases and eliminates the excess CO_2 from the body; its level in the alveolar system increases to the norm. Accordingly, the network of capillaries opens up, the level of deoxygenated oxyhemoglobin increases, and oxygen starvation of the cells is gradually eliminated. Metabolic processes are thus normalized and the symptoms of many diseases disappear.

Moreover, cells acquire a reserve of oxygen, making it possible to carry out extreme physical activity and bear greater levels of mental stress, thus helping to prevent myocardial infarction [1].

RMV is a key indicator of the actual status of the body [11]. It has been shown that a person can remain healthy and active for decades, if his or her RMV does not exceed 4.5 liters per minute. The greater the amount by which the RMV exceeds this level, the more symptoms of pathology arise. Those who suffer from the diseases of civilization may have RMVs of 8–12 liters per minute. This seems like a very drastic law of physiology. But fortunately, for millions of people, the reverse process also makes sense: that is, the gradual reduction of the RMV to normal levels and the gradual recovery of health – as can be achieved with regular simulation training.

Such simulation training is an imperative of our times, when people with reduced health potential are forced to do rehabilitation exercises; such people should exercise in a way that is safe, easily available, quick, and correlates with the health level. But exercise may be too difficult, or unsafe for hypertensive or asthmatic patient, not to mention for elderly people, to begin the process of restoring health in the traditional way. These people should have an opportunity to train in a different way and have an alternative method for restoring their health. Studies of hypercapnic training involving different age groups (in Belarus, Germany, and Russia) have shown that this method optimizes the activities of the cardiovascular system of young and elderly people, and even of highly skilled athletes, and leads to normalization of the main indicators of health. At the end of the training course, a medical examination was performed, only rarely uncovering features of functional diseases [12–13].

Conclusions

1. Tissue hypoxia – the main reason for the decrease in energy and for pathology – is a consequence of the disturbance of homeostasis of the gas composition in the blood, in the form of a lack of carbon dioxide, the main regulator of metabolism.

2. To restore the homeostasis of the gas composition of the blood, and to restore the normal physiology of the body, repeated, daily, long-term, high level physiological hypercapnia is needed.

3. Physiological hypercapnia results from physical activity during long-term exercises (walking, running, etc.), or from breathing exercises that reduce pulmonary ventilation (yoga exercises, MVEDB).

4. The use of environmental factors in the form of an active breathing mixture, which is formed during natural breathing with the capnicator (physical simulator), is another possible training method for achieving the level of physiological hypercapnia and elimination of hypoxia required for normal physiology.

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