ROLE OF SELENIUM IN THE PATHOGENESIS OF ATHEROSCLEROSIS DEVELOPMENT

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Abstract
The article provides an overview of foreign and national publications, as well as the results of our own research, indicates the importance of the selenium status for vital enzymatic reactions in all metabolic processes of organism. It is shown that this microelement prevents the development of cardiovascular diseases, including atherosclerosis through participation in regulation of redox reactions in the body.

Keywords: selenium, atherosclerosis, pathogenesis, lipid peroxidation.

The World Health Organization predicts that global economic prosperity could lead to an epidemic of atherosclerosis [18]. Atherosclerosis is a chronic inflammatory disease initiated by a local immune response to lipid deposition, which has been recognized as the leading cause of stroke, heart disease and even death worldwide [10]. The leading role in the development of the atherosclerotic process, as known, belongs to hyperlipidemia - hypertriglyceridemia, hypercholesterolemia with an increase in β-lipoproteins of low and very low density at a low level of high density lipids. Atherogenic lipoproteins are able to penetrate into the vascular wall from blood plasma and subsequently serve as a substrate for atherosclerotic lesions of arteries [6]. The developed autoimmune theory of the pathogenesis of atherosclerosis testifies to the formation of very low density lipoproteins that have autoimmune properties. As a result of the further formation of antibodies, autoimmune complexes are formed that impair the permeability of the vascular wall, which, in turn, contributes to the infiltration of atherogenic lipoproteins and the further development of the atherosclerotic process [6, 10].

At present, in the mechanism of pathogenesis of atherosclerosis much attention is paid to the processes of lipid peroxidation [1, 21]. It is found that the traditional coronary risk factors do not fully explain differences in the incidence of cardiovascular disease. An unfavorable environmental situation, changes in the structure of the nutrition lead to a disorder of the metabolism of trace elements [9].

An adequate micronutrient supply of the human body plays an important role for its normal functioning [2, 12], because the excess or lack of separate chemical elements or their compounds often leads to pathological conditions, which is potentiated by the particularly increased need of the human body for antioxidant elements such as selenium [3, 20, 22].

Nowadays, more than 25 selenoproteins have been identified in humans, about half of which are enzymes (selenoenzymes), involved in the regulation of redox reactions in the body, controlling glucose homeostasis and preventing neurodegeneration by reducing oxidative stress factors, participating in the synthesis of thyroid hormones, protein synthesis, etc. [1, 17, 23].

Selenium is a cofactor in a number of redox processes. In the lack of selenium activation of lipid peroxidation is observed: an increase in the number of hydroperoxides, malondialdehyde in the blood serum [16]. In combination with beta-carotene, selenium promotes the metabolism of fats, prevents hypertension and platelet agglutination, thereby reducing the risk of heart attacks. Selenium is involved in the synthesis of coenzyme Q-10, which is important for heart health and recovery of the heart muscle after a heart attack, it improves the functioning of mitochondria of heart cells, protecting against oxygen deficiency. Alimentary deficiency of selenium contributes to the development of cardiomyopathy, serves as a risk factor for coronary diseases and myocardial infarction [19].

In numerous works of scientists, it is proved that nutritional deficiency of selenium contributes to the development of atherosclerosis and its progression [4, 6, 9, 11, 12, 22]. Selenoproteins, which play a special role in atherosclerosis, are glutathione peroxidase, thioredoxin reductase I, selenoprotein P, selenoprotein S. The main mechanisms of selenium exposure are: modulation of inflammation, suppression of endothelial dysfunction, inhibition of oxidative stress and protection of vascular cells from apoptosis and calcification [9].

In vivo and in vitro researches [15] there was revealed, that selenium protects homocysteine-induced endothelial dysfunction, prevents endothelial damage and impaired endothelium-dependent vasodilation.

So, in the researches of A.I. Pertsovskikh et al. [11] the data on selenium antioxidant activity in cholesterol model of atherosclerosis are given. As a result of the experiment, it was found that the hypercholesterol diet led to a significant (3-4 times) increase in blood cholesterol. The use of sodium selenite showed a pronounced angioprotective effect of selenium, which manifested itself in a decrease in the degree of damage to the aorta caused by atherosclerotic plaques (by 2-2.5 times) compared with the control group of animals not receiving selenium preparations. The combination of galvanization and selenium preparations contributed to a significant decrease in cholesterol and β-lipoproteins. Thus, studies conducted by the scientists have proven the antiatherogenic effect of physiological doses of selenium in experimental atherosclerosis.

The role of the trace element in preventing the development of atherosclerosis and normalization of lipid metabolism was shown in studies [22] on an experimental model of hypercholesterolemia followed by the introduction of mineral (first group) and organic (second group) selenium compounds into the diet of animals. Hypercholesterolemia led to the disorder of selenium status, characterized by a decrease in the concentration of selenium in the blood, myocardium, liver and

lungs - respectively, up to 35, 65, 70 and 25% of the initial level in relation to the group of control animals. Under the conditions of hypercholesterolemia, activation of lipid peroxidation was observed, which led to an increase in the level of malondialdehyde and its derivatives with a significant decrease in GPX activity. The use of selenium preparations in experimental conditions led to an increase in the selenium content in the blood up to 90-100% of the initial level and contributed to normalization of this element concentration in the organs. Under the influence of selenium preparations, there was a decrease in triacylglycerides, an increase in the level of phospholipids, a decrease in the level of total cholesterol, a decrease in the content of malondialdehyde in the blood serum and GPX activity in the blood by 27-33% [5]. A comparative analysis of mineral and organic forms of the microelement testifies that bioselenium is absorbed faster and better, is included in the metabolism, being able to be deposited in the tissues, as compared with sodium selenite which needs biotransformations.

Another experimental study [7] proves the positive effect of selenium-containing products to counteract arsenic-induced oxidative stress in laboratory mice. In experimental conditions, the formation of lipid plaques in the sinus was reduced and completely eliminated in the aortic arch of mice on a diet with selenium-enriched lentils. It is noteworthy that selenium deficiency promoted the atherogenic composition of serum lipids in mice exposed to arsenic, as indicated by the ratio of high density lipoprotein: low density lipoprotein.

After analyzing the experimental evidence of the antiatherosclerotic effect of selenium on the animal organism, in our epidemiological studies we decided to focus on determining the effect of selenium on the level of atherosclerotic morbidity of the adult able-bodied population of the Dnipropetrovsk region as an industrialized territory [3].

As a result of our epidemiological studies and their analysis [2, 3], facts of the dependence of atherosclerosis from the territory of residence, gender and age of the population were revealed. Thus, the mortality from atherosclerosis of the adult population of industrial territories aged 18-59 years was by 70% higher compared with the inhabitants of the control, conditionally "clean" territories. Morbidity and mortality rate of the male population from atherosclerosis is by 1.1-7.8 times higher compared to the female population ($p<0.05$). With age, morbidity and mortality rate from atherosclerosis in the age category of 40-59 years increases by 9-14 times compared with younger age groups (18-29 and 30-39 years). The obtained statistical data served as the basis for in-depth mathematical and statistical analyses, which made it possible to identify certain factor-effective patterns.

So, in our studies it was revealed that the content of selenium in food rations is negatively and quite tightly correlates with a decrease in mortality from atherosclerosis ($r = -0.90$, $p <0.01$). A similar negative and quite close correlation was found between mortality from atherosclerosis and serum selenium concentration ($r = -0.96$, $p <0.001$). For a more evidence-based and detailed analysis of the dependence of mortality from atherosclerosis on the level of selenium intake in the body, a regression analysis was used, the model of the revealed dependence of which: $y = 2.31-19.42x$, where: y - the value of mortality from atherosclerosis, x - the value of the concentration of selenium in the diet. Our results are identical to epidemic research of foreign authors [14, 20] regarding the negative correlation between the level of selenium in the blood plasma and the risk of atherosclerosis development.

However, despite the foregoing, the benefits of taking this microelement in the prevention of atherosclerosis are still poorly understood. For example in the work [8] it has been shown that a more prolonged selenium impact may be associated with a risk of dyslipidemia in the elderly. Therefore, much more research is necessary to prove the role of selenium in the prevention of atherosclerosis and to precise the mechanism of its impact.

Conclusion. An analysis of foreign and national publications, as well as the results of our own research, indicates the importance of the elemental composition of the body, including selenium status, for vital enzymatic reactions in all metabolic processes. Numerous studies have shown that selenium is a vital element that is involved in the regulation of redox reactions in the body, prevents development of cardiovascular diseases, including myocardial infarct, cerebrovascular disease and atherosclerosis by reducing oxidative stress factors and, possibly, through other mechanisms of pathogenesis. However, the use of this microelement as a prophylactic agent for the development of atherosclerosis has not found wide application through the ambiguous results of its effectiveness, which requires further research.

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ТЕХНИКА «СИЛИКОНОВОГО КЛЮЧА», КАК НОВЫЙ ПОДХОД К ВОССТАНОВЛЕНИЮ ЖЕВАТЕЛЬНОЙ ПОВЕРХНОСТИ ЗУБОВ

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THE “SILICONE KEY” TECHNIQUE AS A NEW APPROACH TO RESTORING A CHEWING SURFACE OF TEETH

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Аннотация

В статье рассматривается проблема оптимизации восстановления жевательной поверхности зубов с помощью техники «силиконового ключа». Проведенное авторами исследование демонстрирует высокую эффективность данной методики: из 96 зубов, запломбированных с ее помощью у 78 (81,3%) дальнейшей коррекции не потребовалось, однако, в 18,7% случаев – окклюзионно-артикуляционная коррекция оказалась необходима.

Abstract

The article discusses the problem of optimizing the chewing surface restoration of teeth using the "silicone key" technique. The study conducted by the authors demonstrates the high efficiency of this technique: out of 96