THE ROLE OF SELENIUM IN CARDIOLOGY

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Abstract. Selenium is an important trace element that is fundamental for the functioning of the human body. Being part of the active site of a number of antioxidant enzymes, selenium prevents damage to body cells by free radicals. A decrease in the synthesis of selenium-containing enzymes leads to the progression of oxidative stress and chronic inflammation, which are considered possible causes of many cardiovascular diseases. This review examines the mechanisms by which an adequate supply of selenium to the body can prevent myocardial and vascular damage, and also emphasizes the importance of monitoring and correcting the selenium status of specialized patients.

Keywords: Selenium, oxidative stress, microelements, glutathione peroxidase, antioxidants, cardiovascular diseases, selenoproteins.

INTRODUCTION

Selenium is one of the essential (essential) microelements, an adequate supply of which is necessary to ensure health. This was first shown in experiments on animals that developed muscular dystrophy, cardiomyopathy, and liver cirrhosis on a selenium-deficient diet [1, 2]. In the body, selenium is presented in the composition of selenoproteins, which include a number of important enzymes such as glutathione peroxidase, thioredoxin reductase, iodothyronine deiodinase, etc. Basically, the functions of selenium-containing proteins are reduced to preventing the development of oxidative stress and reducing the inflammatory process that provoke development of cardiovascular pathologies [3].

MATERIALS AND METHODS

The main source of selenium for humans is food of plant and animal origin. Food products of all types demonstrate a geographic pattern of changes in selenium content, since it depends on the amount of dissolved selenium in the soil and the ability of plants to absorb it [2]. Based on the concentration of the microelement in blood serum, three groups of regions are distinguished: with low (60–80 μg/l), medium (81–115 μg/l) and high (more than 120 μg/l) selenium content [3].

RESULTS AND DISCUSSION

Selenium enters the body with water (10%) and food of plant and animal origin (90%) [4]. The largest amount of selenium is found in yeast, Brazil nuts, seafood, meat, cereals and other products. However, even with sufficient intake from food, the supply of selenium to the human body depends on bioavailability, which is determined by the nature of its chemical form [3].

The main form in cereals and other plants is selenomethionine. Selenocysteine is considered the most likely compound in animal meat [2]. Inorganic selenites are absorbed by simple diffusion, and selenates are absorbed with the Na+ ion or antiport with the OH– ion. Organic forms have the best bioavailability; they are imported into the enterocyte with the Na+ ion, just like neutral amino acids. The process of absorption of selenium-containing compounds occurs mainly in the duodenum and is completed in the distal small intestine. It is believed that the absorption of a number of selenium compounds is potentiated by vitamins A, E and C and inhibited by sulfur, calcium and Fe3+ ions [3].

After entering the body, inorganic selenite ions are quickly and selectively absorbed by erythrocytes, where they are reduced by glutathione and glutathione reductase and transported in plasma in the form of hydroselenide, which selectively binds to albumin [3]. Selenate ions are also quickly reduced enzymatically to hydrogen selenium, which is present at physiological pH values mainly in the form of hydroselenide anion [2]. A certain amount of the resulting

hydrogen selenide quickly binds to transport proteins, forming a labile ("exchangeable with selenite") pool of selenium [3].

A significant amount of selenium compound metabolites (50–60%) is released in the urine. In women, selenium excretion through the urinary tract is significantly higher than in men, which indicates gender dimorphism in the biosynthesis of selenoproteins [4].

Selenium can be deposited in various organs and tissues. The highest concentrations are observed in the kidneys, since this is the main organ of selenium excretion; slightly less is found in the liver and pancreas, followed by cardiac and skeletal muscles.

As already mentioned, most of the selenium in the body of animals and humans is contained in the form of a selenium compound with proteins. It is estimated that up to 100 selenoproteins may exist in mammalian systems. To date, about 25 of them have been functionally described [3]. Most of the identified selenoproteins are enzymes in which the selenocysteine moiety is responsible for the catalytic properties. Each inclusion of selenocysteine in the protein structure is specific and aimed at enhancing its antioxidant capabilities. In contrast to the mercapto group in cysteine-containing enzymes, the selenol radical is completely ionized at physiological pH, due to which selenium-containing enzymes have a much higher reactivity.

Glutathione peroxidases

Glutathione peroxidases are one of the most effective families of anti-peroxide enzymes expressed by vascular endothelial cells. The main function of this subgroup of enzymes is to maintain a stable concentration of reduced glutathione.

The state of the cardiovascular system is mainly affected by three types of glutathione peroxidases: classical or cytosolic glutathione peroxidase (cGPx, GPx-1) (which is most dependent on the selenium content in the body), extracellular

plasma glutathione peroxidase (pGPx, GPx-3), phospholipid glutathione peroxidase (PHGPx, GPx-4).

Thioredoxin reductase

Thioredoxin reductases are FAD-containing homodimeric enzymes belonging to the family of pyridine oxidoreductases. A feature of this group of enzymes is the presence of a C-terminal selenocysteine fragment connected to the adjacent cysteine, which constitutes the active selenosulfide site. Thioredoxin reductase reduces low molecular weight compounds and is a key enzyme in selenium metabolism. The effects mediated by the work of thioredoxin reductases are aimed at the repair of other enzymes, reducing the consequences of oxidative stress, including in the myocardium.

Selenoproteins P, S, K, W, T

Other selenoproteins are also isolated, for example, selenoprotein P (SeP), which is considered the most numerous selenium-containing protein and the main transporter of selenium to peripheral tissues. It is the only protein containing more than one selenium atom (according to some data, their number reaches 10), however, this number is not constant, since SeP acts as a donor of selenium atoms for other selenium-dependent enzymes and circulates in the blood in the form of isoforms. SeP is synthesized predominantly in the liver, but also exists in cells that are capable of reproducing it in other organs. In addition to transport duties, it itself has antioxidant properties, preventing cell damage, which is confirmed by the experiment of Rock et al, where in vitro fluorescent analysis demonstrated the ability of SeP to prevent the appearance of membrane lipid hydroperoxides generated by lipoxygenase.

CONCLUSION

Over the past decades, significant progress has been made in understanding the role of selenium and selenium-containing enzymes for human health. Based on

the results of various basic and clinical studies, it can be said that maintaining adequate levels of selenium and the functioning of selenium-containing enzymes can reduce the incidence and severity of heart and vascular diseases such as atherosclerosis, heart failure, myocardial infarction, as well as reduce ischemic and free radical damage to the heart, in connection with which it seems important to take into account the selenium content in the body in specialized patients.

Control and optimization of selenium status, especially in the population of selenium-deficient areas, by adding food products enriched with selenium and/or biological selenium supplements to the diet, is one of the directions in reducing the risks of the occurrence and development of cardiovascular diseases.

REFERENCES

1. Yoshida T, Maulik N, Engelman RM, Ho YS, Magnenat JL, Rousou JA et al. Glutathione peroxidase knockout mice are susceptible to myocardial ischemia reperfusion injury. Circulation. 2017;96(9 Suppl):II-216–20. PMID: 9386101

2. Ardanaz N, Yang X-P, Cifuentes ME, Haurani MJ, Jackson KW, Liao T-D et al. Lack of Glutathione Peroxidase 1 Accelerates Cardiac- Specific Hypertrophy and Dysfunction in Angiotensin II Hypertension. Hypertension. 2010;55(1):116–23. DOI: 10.1161/HYPER-TENSIONAHA.109.135715

3. Huang Z, Rose AH, Hoffmann PR. The Role of Selenium in Inflammation and Immunity: From Molecular Mechanisms to Therapeutic Opportunities. Antioxidants & Redox Signaling. 2012;16(7):705–43. DOI: 10.1089/ars.2011.4145

4. Bansal MP, Kaur P. Selenium, a versatile trace element: current research implications. Indian Journal of Experimental Biology. 2015;43(12):1119–29. PMID: 16359122