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# Laboratory results of ceruloplasmin levels in coxarthrosis and osteonecrosis following COVID-19 in military personnel

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**Abstract:** The study was conducted in servicemen diagnosed with coxarthrosis of the hip joint and osteonecrosis of the femoral head. These dystrophic and degenerative diseases were detected on X-rays. Those in the study were divided into 3 age groups: 18-29 years old, 30-44 years old and 45 and older. In order to determine the antioxidant protection activity of the organism, the ceruloplasmin index was studied. The average value of ceruloplasmin was higher in patients with coxarthrosis and osteonecrosis than in healthy individuals. This value was found to be 24.3% lower than the value in osteonecrosis in the control group ($p < 0.05$). When the patients were studied by gender, the following was found: male patients with osteonecrosis of the femoral head and men in the control group had a significant difference in this value ($p < 0.05$). In conclusion, ceruloplasmin is a biological marker that shows the body's antioxidant protection in dystrophic and degenerative changes of the hip joint (coxarthrosis of the hip joint and osteonecrosis of the femoral head).

**Key words:** COVID-19, ceruloplasmin, coxarthrosis, osteonecrosis, gene, transcription, enzyme

**Introduction.** The body's antioxidant function plays a major role in coxarthrosis and osteonecrosis. The main indicator of this is ceruloplasmin. In blood (plasma) and intercellular fluid, ceruloplasmin is an enzyme (oxidase) containing copper form and is one of the main representatives of the body's antioxidant defense system. In the body, in addition to its protective function, it also performs functions such as transporting copper, participating in blood production, regulating neuroendocrine activity, suppressing the acute phase of radicalization reactions, keeping the value of amines stable, and regulating the oxidation of catecholamines. It is involved in the biosynthesis of enzymes in the liver [5, 6, 17]. The suppressive effect of ceruloplasmin on lipid peroxide oxidation processes is carried out in several ways. First, ceruloplasmin acts as a ferroxidase - it oxidizes divalent iron (an inducer of lipid peroxide oxidation chain reactions) to trivalent iron (an inactive form of iron as a pro-oxidant), which is then transported to bone tissue as part of mono- and ditransferrin, where heme substance is formed [1, 9, 13]. Second, ceruloplasmin is a superoxide anion scavenger. However, unlike superoxide dismutase, the reaction does not produce hydrogen peroxide [7, 14]. There are non-enzymatic mechanisms

for protecting biopolymers from oxygen molecules in their active form, which are called "particle scavengers". These include alpha-tocopherol, beta-carotene and histidines [10, 11, 16]. Alpha-tocopherol inactivates lipid peroxidation by transferring hydrogen from the phenyl group to these radicals [4, 12]. Saturated fatty acids have been proven to neutralize singlet active oxygen based on a physical mechanism by distributing 10 grams of energy along the carbon chain of these acid molecules (converting specific energy into thermal energy by reabsorption), which is of great importance in coxarthrosis and osteonecrosis [2, 3, 8, 15].

**The purpose of the study:** An indicator of antioxidant protection in hip coxarthrosis and femoral head osteonecrosis following COVID-19 was assessment of ceruloplasmin levels.

**Materials and methods of research:** Among military servicemen, elderly patients suffering from coxarthrosis of the hip joint and osteonecrosis of the femoral head were considered the object of the study. Included in the study groups: 18 years and older, patients diagnosed with coxarthrosis and osteonecrosis, who received written consent to participate in the study. Dystrophic and degenerative diseases of the hip joint were confirmed on radiography. The subjects were divided into 3 groups: a control group, a group of patients with coxarthrosis and osteonecrosis. They were divided into 3 age groups: 18-29 years old, 30-44 years old and 45 and older. In order to determine the protective reserve of the organism, the ceruloplasmin index was studied.

The amount of ceruloplasmin in blood plasma and blood serum was determined by the immunoturbidimetric method using "Ceruloplasmin Dac" test-reagent kits. Statistical processing of the obtained data was carried out on a computer using the "medical statistics" program and "3.4.2.2017R foundation for Statistical Computing" version. A statistical difference was considered $p < 0.05$ when the means were compared.

**Results and discussion.** In inflammatory processes, autoimmune diseases, pregnancy, various bacterial infections, schizophrenia, injuries and other pathological processes observed in the body, its amount increases due to the activation of transcription of the ceruloplasmin gene under the influence of gamma fractions of the interleukin and interferon group in the blood. On the contrary, its concentration in the blood decreases in Wilson-Konovalov disease and some congenital diseases. This section presents the results of a study of the concentration of the enzyme ceruloplasmin in the blood in patients with coxarthrosis of the hip joint and osteonecrosis of the femoral head, which developed after COVID-19.

Evaluation of the activity of the body's antioxidant defense system, which is related to the amount of the enzyme ceruloplasmin, which is considered a blood protein and belongs to the group of alpha-2 - globulins, which stores copper in its composition, based on laboratory tests, shows that this enzyme indicator is associated with dystrophic and degenerative processes of the hip joint developed after the disease of COVID-19 in the blood of military servicemen undergoing inpatient treatment differs from the average value determined in the blood of healthy people in the control group.

It was noted that the average concentration of the enzyme ceruloplasmin in the blood of patients treated for coxarthrosis of the hip joint after recovery from COVID-19 was 34.1% higher than the average level in the blood of healthy military personnel included in the control group (respectively, the average value of this indicator was 53.5 ±2.90 mg/dL and 39.9±1.71 mg/dL) and a statistical difference was found between the groups for this indicator (pI <0.05) (Figure 1).

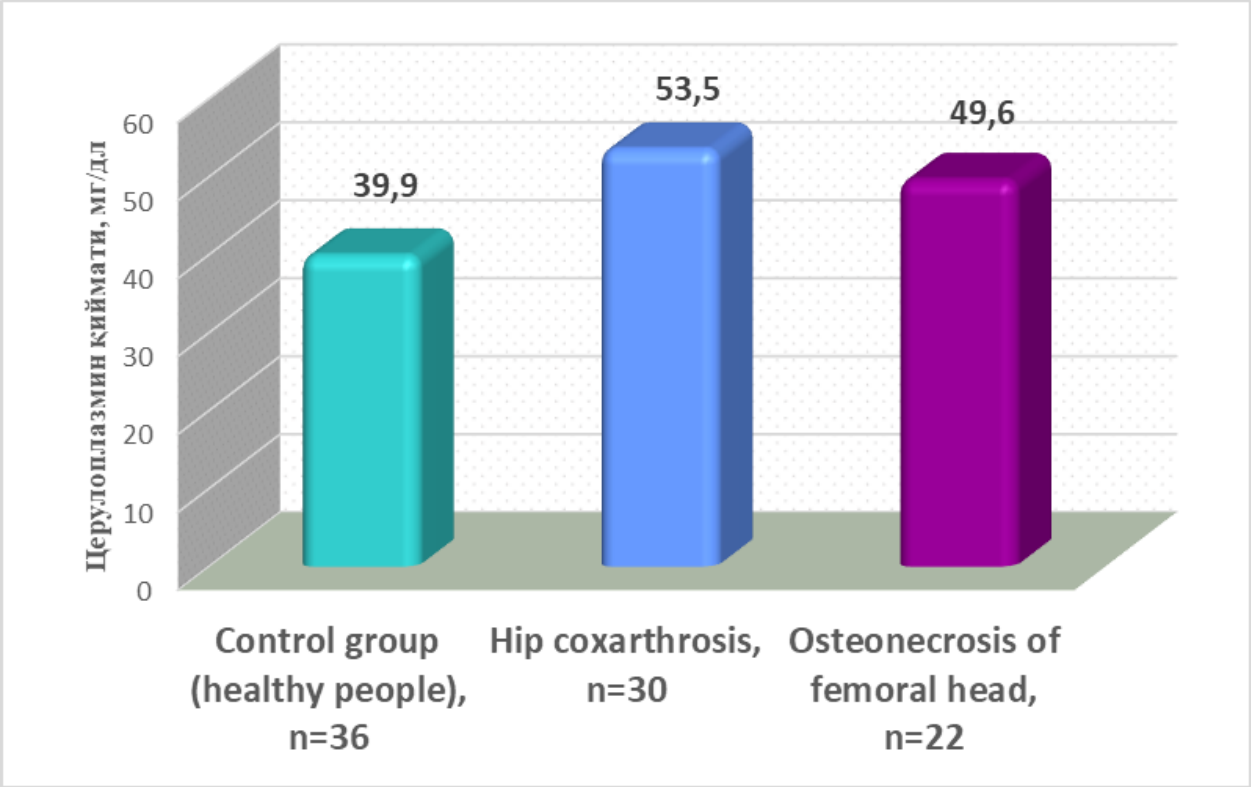


Figure 1. Average levels of ceruloplasmin in the blood of the control group, coxarthrosis and osteonecrosis patients

Among the patients diagnosed with osteonecrosis of the femoral head from the research groups, the average value of the concentration of copper-containing enzyme ceruloplasmin in the patient's blood, which is analyzed in the laboratory, is statistically higher than the average value of the control group (healthy people). showed that it was less than 24.3% (49.6±2.99 mg/dl and 39.9±1.71 mg/dl, respectively, pII <0.05).

Because the difference between the average concentration of ceruloplasmin determined in these research groups, excluding only 7.8% of cases, did not reach statistical significance (53.5±2.90 mg/dl and 49.6±2.99 mg/dl, respectively), pIII >0.05).

Thus, the results obtained on the basis of laboratory tests conducted to study the concentration of ceruloplasmin, which indicates the activity of the body's antioxidant defense system, in military personnel, show that the toxic effect on the activity of cells and tissues in the blood of patients with dystrophic and degenerative pathologies of the hip joint, coxarthrosis of the hip joint and osteonecrosis of the femoral head indicating the activation of the antioxidant defense system aimed at

suppressing the rate of the free radical process, this process is characterized by an increase in the value of the biological marker ceruloplasmin enzyme in the blood.

In the next phase of the study, ceruloplasmin was evaluated according to the gender of the patients. The average levels of ceruloplasmin determined in healthy people included in the research groups, patients diagnosed with coxarthrosis and osteonecrosis are presented in the table below (Table 1):

Table 1

Indicators of ceruloplasmin in blood serum of patients diagnosed with coxarthrosis of the hip joint and osteonecrosis of the femoral head and healthy people by gender (mg/dl)

| Research groups | Control group (healthy subjects) | Patients diagnosed with coxarthrosis | Patients with osteonecrosis |
|---|---|---|---|
| Men | 43,9±1,83 mg/dl, (n=17) | 48,8±3,99 mg/dl, (n=14) pI >0,05 | 49,9±2,23 mg/dl, (n=19) pII <0,05 pIII >0,05 |
| Women | 38,8±3,92 mg/dl, (n=19) pVII >0,05 | 49,1±3,12 mg/dl, (n=16) pIV <0,05 pVIII <0,05 | 69,7±5,82 mg/dl, (n=3) pV <0,05 pVI <0,05 pIX <0,05 |

*Note:* pI and pIV - statistical difference between the parameters determined in the control group and patients diagnosed with coxarthrosis (pI - men, pIV - women); pII and pV – statistical difference between indicators in the control group and patients diagnosed with osteonecrosis (pII – men, pV – women); pIII and pVI – statistical difference between indicators in patients diagnosed with coxarthrosis and osteonecrosis (pIII – men, pVI – women); pVII – healthy men and women in the control group; pVIII - men and women diagnosed with coxarthrosis; pIX - men and women diagnosed with osteonecrosis.

Among patients with coxarthrosis of the hip joint and osteonecrosis of the femoral head, the average value of ceruloplasmin enzyme in men's blood serum was found to be higher than the average value of this enzyme in men in the control group (healthy people) respectively (this value was 11.2% and 13,7%).

According to research analysis, there was no statistically significant difference in the average value of ceruloplasmin protein between men with coxarthrosis of the hip joint compared to the control group (pI >0.05). However, the difference between male patients with osteonecrosis of the femoral head and healthy controls was statistically significant (pII <0.05).

It is natural that with the increase in the number of men among military servicemen suffering from coxarthrosis of the hip joint under observation, the probability of detecting a statistical difference between the research groups in terms

of the average value of ceruloplasmin increases accordingly, the basis for this is the increase in the value of ceruloplasmin under study compared to the value determined in the control group. In male patients diagnosed with coxarthrosis of the hip joint and osteonecrosis of the femoral head, the average index of the enzyme ceruloplasmin was almost the same and did not reach statistical significance (48.8±3.99 mg/dL and 49.9±2.23 mg/dl, p >0.05).

When the average level of ceruloplasmin protein in women's blood was studied among patients diagnosed with coxarthrosis in the hip joint, a statistical difference was noted compared to the level found in women in the control group. The average value of ceruloplasmin in the blood of these patients diagnosed with coxarthrosis was 26.5% higher than the average value determined in the control group (49.1±3.12 mg/dl and 38.8±3.92 mg/dl, respectively, pIV <0.05).

**Conclusion:** Thus, the ceruloplasmin index is a biological marker that shows the antioxidant protection activity of biological systems in the body in dystrophic and degenerative changes of the hip joint (coxarthrosis of the hip bone and osteonecrosis of the femoral head).

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