

en method required improvement of a quality of applied metal clamps in order to increase their strength properties, as well as technical support the possibility of their modeling during the operation.

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INFLUENCE OF ANDROGEN DEFICIENCY ON THE FORMATION OF DISORDERS OF THE CARDIOVASCULAR SYSTEM DURING PUBERTY, TAKING INTO ACCOUNT CHANGES IN OXIDATIVE BALANCE

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Disorders of metabolic processes in the male body are closely interrelated with androgen deficiency, which is one of the mechanisms of the onset and progression of pathological conditions, in particular, the cardiovascular system (CVS) [1]. The relationship between testosterone level and the state of oxidative stress has been proven [2]. According to the literature, the role of free radical oxidation (FRO) and antioxidant defense (AOD) processes in the onset and development of CVS diseases in children has been established [3].

However, studies of the influence of androgen deficiency on the state of the FRO and AOD processes in CVS disorders were carried out under experimental conditions on animals or concern mainly adult men.

In this regard, the purpose of this study is to investigate the effect of hypoandrogenism (HA) in adolescents on the indicators of oxidative balance in violation of the functional state of the CVS.

Materials and methods. The study included 57 adolescents aged 13–18 years with HA and functional disorders of the CVS. The state of CVS was assessed using functional indices: endurance coefficient (EC) and

blood circulation efficiency coefficient (BCEC). An increase in EC over 20 c.u. was considered a weakening, and a decrease less than 16 c.u. – an increasing the functionality of the CVS. Increase of BCEC over 2600 c.u. testified to the savings in the expenditure of CVS reserves, that is, to the decrease in the body's energy consumption for blood circulation in case of fatigue.

The state of FRO was judged by the level of TBA-active products (TBA), diene conjugates (DC), and carbonylated proteins (CP) in the blood serum. The AOD system was assessed by the content of reduced glutathione (GSH) and the activity of glutathione peroxidase (GPx) in whole blood, the activity of superoxide dismutase (SOD) and catalase in the blood serum.

Statistical processing of the results was carried out using the «*Statgraphics Plus 5.1*» software package. To assess the significance of differences, the Mann–Whitney (u) test and the Fisher *F*-test (φ) were used.

Results and discussion

Evaluating the state of the CVS using the EC and BCEC indices, we identified functional disorders in more than half of adolescents with androgen deficiency (62.7 %). Analyzing the changes in FRO and AOD indices in boys with HA at different EC values, an increase in the concentration of DC and CP in blood serum was found to a greater extent with a weakening of the functional capabilities of the CVS (EC is more than 20 c.u.).

At the same time, the content of DC increased by 43.3 % compared to the normal functional state of the CVS and amounted to 0.66 ± 0.06 nmol/L, respectively, in contrast to 0.46 ± 0.06 nmol/L ($p_u < 0.05$), and the CP level increased 1.6 times and corresponded to 1.33 ± 0.12 U/ml compared to 0.88 ± 0.10 U/ml, respectively ($p_u < 0.01$). Moreover, in adolescents with HA, with weakening of the functional capabilities of the CVS, high CP values were reliably more frequent than with its satisfactory state (76.9 % and 35.3 %, respectively; $p_\varphi < 0.005$).

Simultaneously with the intensification of the FRO processes in boys with androgen deficiency against the background of a decrease in the functional capabilities of the CVS, an increase (by 26.9 %) in SOD activity was recorded from 1.33 ± 0.10 U/min•ml to 1.65 ± 0.06 U/min•ml ($p_u < 0.04$). At the same time, a high level of the enzyme was observed in them 2 times more often (61.5 % and 29.4 %; $p_\varphi < 0.03$). SOD belongs to the enzymes of the initial stage of FRO, deactivates the superoxide radical, converting it to less reactive hydrogen peroxide.

In parallel with the activation of the AOD enzymatic link, an increase (by 33.3 %) in the content of GSH in whole blood was noted (0.48 ± 0.06

$\mu\text{mol/L}$ and $0.36 \pm 0.07 \mu\text{mol/L}$, respectively; $p_u < 0.04$). Moreover, a high concentration of the antioxidant was found in 76.9 % of patients, which evidently indicates a compensatory reaction of one of the main low-molecular antioxidants, aimed at neutralizing the toxic products of FRO.

With a decrease in the body's energy consumption for blood circulation (the average values of the BCEC were 3636.58 ± 171.78 c.u.), in comparison with the normal work of the heart, inhibition of the activity of anti-peroxide protection enzymes was observed, in particular, GPx ($7.37 \pm 0.48 \mu\text{mol/min}\cdot\text{ml}$ and $9.05 \pm 0.78 \mu\text{mol/min}\cdot\text{ml}$, respectively; $p_u < 0.06$) and catalase ($17.07 \pm 1.87 \mu\text{mol/min}\cdot\text{ml}$ and $23.86 \pm 3.62 \mu\text{mol/min}\cdot\text{ml}$; $p_u < 0.05$). It draws attention to the fact that boys with reduced CVS reserve capabilities are 1.5 times less likely to have high rates of SOD activity (37.4 % and 57.9 %; $p_\phi < 0.05$).

Conclusions. Thus, in adolescents with HA and functional disorders of the CVS, stimulation of FRO processes and inhibition of the AOD system are recorded. The imbalance in the ratio of these processes is more pronounced with the weakening of the functional capabilities of the heart. The detected changes indicate functional tension of the CVS and a decrease in the adaptive reactions of the boys' body with androgen deficiency.

Excessive formation of highly toxic products of FRO (DC and CP) under conditions of inhibition of the activity of antioxidant enzymes (GPx, catalase) can cause disruption of the structure and function of cell membranes of cardiocytes and the development of chronic CVS diseases.

To date, 15.4 % of boys with HA have some sort of CVS pathology (cardiopathy, mitral valve prolapse, etc.), which must be taken into account when treating this contingent of adolescents.

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