The influence of selenium on the morphological changes of the myocardium during the formation of experimental diabetes mellitus

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Abstract. In an experiment on animals, the effect of alkylselenonaphthyridine on the formation of morphofunctional changes in the myocardium was studied when modeling diabetes mellitus. It was found that the administration of selenium during the formation of experimental diabetes mellitus limited the development of ventricular hypertrophy of the heart. At the same time, in animals of the experimental group with the development of diabetes mellitus against the background of selenium administration, no pronounced morphological changes in the myocardium were found.

Keywords: diabetes mellitus, selenium, myocardium, hypertrophy, histology
In 2010, the total number of people with all forms of diabetes was about 239 million. According to the forecasts of the International Diabetes Federation (IDF), the number of people with diabetes among adults (20-79 years old) will increase to 439 million (or 7.8% of the total population) by 2030 [1].

This determines the relevance of research into diabetes, one of the directions of which is the study of the effect of antioxidants. To date, the role of substances containing selenium in increasing myocardial tolerance in diabetes mellitus diabetes and reducing the risk of developing cardiomyopathy.

It is known that pathological processes caused by endogenous intoxication are accompanied by the initiation of free radical processes. Diabetes mellitus is associated with severe oxidative stress. Therefore, an imbalance between oxidants and antioxidants may lead to neurodegeneration in the development of diabetes mellitus [2].

Selenium deficiency has already been shown in animal studies to cause cardiomyopathy and sudden death. In humans, selenium deficiency is one of the links in the chain of etiological prerequisites for the development of cardiovascular pathology. This may be important in explaining the pathophysiology of cardiovascular diseases [3, 4].

The therapeutic effect of selenium in the prevention of neurodegeneration and treatment of diseases of the cardiovascular system (CVS), in particular in the development of diabetes mellitus, remains insufficiently studied.

The study was carried out on 46 male Wistar rats weighing 220-280 g, which were kept on a standard diet in the vivarium of the Department of Anatomy, Physiology Human and Animals of the Lugansk Taras Shevchenko National University.

The keeping and care of rats was carried out in compliance with bioethics and the principles of the “European Convention for the Protection of Vertebrate Animals”, which are used for experimental and other scientific purposes (Strasbourg, 1985), as well as the decision of the “First National Congress on Bioethics” (Kiev, 2001) [5].

To simulate diabetes mellitus, streptozotocin (SIGMA USA), diluted in 0.5 ml of 0.1 M citrate buffer, was administered intraperitoneally on an empty stomach once a
week at a rate of 25 mg/kg [6].

The substance used as a source of selenium was - alkylselenonaphthyridine ASN (No. 7498352, "Beilstein Handbook"). The daily dose of alkylselenonaphthyridine (180 μg/100 g) in terms of selenium was calculated according to MA Ansari et al. (2004) [7].

Experimental animals were divided into two groups: 1st group, control CG (23 rats), with an experimental model of diabetes mellitus, 2nd group, experimental EG (23 rats), in which alkylselenonaphthyridine was administered from the first day of modeling diabetes mellitus. In animals of the control and experimental groups, before the start of the experiment and 10, 30, 60 days after the start of the experiment, the mass of the myocardium of the ventricles of the heart was calculated; studied the histostructure of the myocardium of the ventricles of the heart.

10 days from the start of the experiment, animals in the CG, the absolute mass of the left ventricular myocardium ranged from 0.600 to 0.732 g. On average, the absolute mass of the left ventricle was 388.01 ± 8.38 times less than the mass of the animal. The relative mass of the left ventricular myocardium ranged from 0.254-0.264 g, which was 1.036 times more than the original indicator.

In the myocardium of the left ventricle animals in the CG after 10 days, staining with GOFP revealed diffusely distributed single fuchsinophilic foci, indicating early ischemic lesions of the myocardium. These lesions were colored red and could extend to 2-3 or more muscle fibers (Fig. 1).

Absolute myocardial mass right ventricle was less than the absolute mass of the left ventricular myocardium of 3.93 times and ranged from 0.1 50 to 0.1 99 g. On average, the absolute mass of the right ventricle was 1524.5 times less than the mass of the animal. Relative the mass of the right ventricular myocardium was in the range of 0.0 62-0.0 72 g, which was 1.212 times more than the initial value.

Histostructure of the myocardium of the right ventricle of animals in the CG had diffusely located fuchsinophilic foci that involved several muscle fibers and had a specific red color (Fig. 2).
30 days from the start of the experiment, animals CG absolute mass of the left ventricular myocardium was 0.604–0.751 g. On average, the absolute mass of the left ventricle was 363.35 times less than the mass of the animal. The relative mass of the left ventricular myocardium was greater than in the previous exposure of the experiment, and ranged from 0.268–0.285 g, which was 1.107 times more than the initial value.

In the plane of the section of the myocardium of the left ventricle animals KG after 30 days, hematoxylin-basic fuchsin-picric acid (HBFPA) staining revealed large fuchsinophilic foci of ischemic myocardial damage (Fig. 3).

The absolute mass of the right ventricular myocardium was less than the absolute mass of the left ventricular myocardium by 3.7 times and ranged from 0.165 to 0.204 g. On average, the absolute mass of the right ventricle was 1343.8 times less than the mass of the animal. The relative mass of the right ventricular myocardium ranged from 0.073 to 0.076 g, which was 1.4 times more than the initial value.
On sections of the myocardium of the right ventricle of CG animals, stained with HBFPA, after 30 days, numerous diffusely located fuchsinophilic foci were identified, which spread to 3 or more muscle fibers (Fig. 4).

![Figure 3](image1.png)  ![Figure 4](image2.png)

Myocardium of the left ventricle animal of the control group after a 30-day exposure to the experiment. HBFPA coloring. LMx200

Myocardium of the right ventricle animal of the control group after a 30-day exposure to the experiment. HBFPA coloring. LMx100

After a 60-day exposure to the experiment, animals CG absolute mass of the left ventricular myocardium was 0.852–0.881 g. On average, the absolute mass of the left ventricle was 350.91 times less than the mass of the animal. The relative mass of the left ventricular myocardium was greater than in the previous exposure of the experiment and ranged from 0.282 to 0.289 g, which was 1.15 times more than the initial value.

In the myocardium of the left ventricle animals CG after 60 days, HBFPA staining revealed large fuchsinophilic foci of ischemic damage. On individual sections, foci of hemorrhage were identified, which were oriented near full-blooded venous vessels (Fig. 5).

The absolute mass of the right ventricular myocardium was less than the absolute mass of the left ventricular myocardium by 3.38 times and ranged from 0.246 to 0.265 g. On average, the absolute mass of the right ventricle was 1186.5 times less than the mass of the animal. The relative mass of the
right ventricular myocardium ranged from 0.082 to 0.087 g, which was 1.5 times more than the initial value.

On sections of the myocardium of the right ventricle of CG animals, stained with HBFPA, after 60 days, pronounced venous congestion and fuchsinophilic foci of ischemic myocardial damage were detected (Fig. 6).

In EG animals, the initial values of the absolute mass of the left ventricular myocardium ranged from 0.576 to 0.686 g. On average, the absolute mass of the left ventricle was 410.95 times less than the mass of the animal. The relative mass of the left ventricular myocardium ranged from 0.225 to 0.254 g. The absolute mass of the right ventricular myocardium was 4.8 times less than the absolute mass of the left ventricle myocardium and ranged from 0.106 to 0.156 g. On average, the absolute mass of the right ventricle was less than the mass animal 1991.06 times. The relative mass of the right ventricular myocardium was in the range of 0.044–0.060 g.

10 days from the start of the experiment (introduction alkylselenonaphthyridine) in animals EG, the absolute mass of the left ventricular myocardium was in the range of 0.607–0.692 g, and the relative mass of the left ventricle was 0.250–0.259 g. This was 1.020 times more than the initial
value and 1.017 times less than the indicators for animals in the control group.

In the myocardium of the left ventricle of EG animals, 10 days after staining with HBFPA, fuchsinophilic foci of early ischemic changes in the myocardium were not detected (Fig. 7).

![Figure 7](image)

**Figure 7** Myocardium of the left ventricle of the experimental group, after a 10-day exposure to the experiment. HBFPA coloring. LMx100

![Figure 8](image)

**Figure 8** Myocardium of the right ventricle of an animal from the experimental group, after a 10-day exposure to the experiment. HBFPA coloring. LMx200

After 10 days from the start of the experiment, the absolute mass of the right ventricular myocardium in EG animals was in the range of 0.145–0.161 g, which was 1684.68 times less than the mass of the animal and 4.31 times less than the absolute mass of the left ventricle. The relative mass of the right ventricular myocardium ranged from 0.055 to 0.060 g. This was 1.060 times more than the initial value and 1.14 times less than in the animals of the control group.

In the myocardium of the right ventricle animal EG after 10 days, no fuchsinophilic foci were identified when staining with HBFPA (Fig. 8).

In animals of the experimental group, 30 days from the start of the experiment, the absolute mass of the left ventricular myocardium was 0.637–0.694 g. On average, the absolute mass of the left ventricle was 375.14 times less than the mass of the animal. The relative mass of the left
ventricular myocardium was in the range of 0.258–0.269 g, which was 1.112 times more than the initial values. In comparison with the CG indicators, a decrease in the relative mass of the left ventricle was revealed by 1.043 times.

In the plane of the section of the myocardium of the left ventricle animal EG after a 30-day exposure to the experiment, fuchsinophilic foci of ischemic myocardial damage and moderately dilated veins were identified (Fig. 9).

On the 30th day of the experiment, the absolute mass of the right ventricular myocardium in animals of the experimental group was less than the absolute mass of the left ventricular myocardium by 4.08 times and ranged from 0.158 to 0.167 g. On average, the absolute mass of the right ventricular myocardium was 1531.99 times less than the mass of the animal. The relative left ventricular mass of the right ventricular myocardium ranged from 0.059 to 0.068 g, which was 1.23 times more than the initial value and 1.043 times less than the 30-day experimental exposure in control group animals.
In the myocardium of the right ventricle animals of the experimental group after 30 days, moderately pronounced venous plethora and single fuchsinophilic foci were detected, which were localized along 1-3 muscle fibers (Fig. 10).

60 days from the start of the experiment, animals experimental group absolute mass of the left ventricular myocardium was 0.715-0.801 g. On average, the absolute mass of the left ventricle was 376.05 times less than the mass of the animal. The relative mass of the left ventricular myocardium was in the range of 0.260-0.271 g, which was 1.12 times more than the initial values and 1.035 times less than the values in animals in the control group after a 60-day exposure to the experiment.

In the plane of the section of the myocardium of the left ventricle animals of the experimental group after 60 days, staining with HBFPA revealed fuchsinophilic foci around which large formations formed. Venous congestion was moderately expressed (Fig. 11).

In animals of the experimental group, 60 days after the start of the experiment, and the absolute mass of the right
ventricular myocardium was less than the absolute left ventricular myocardial mass at 4.15 times and ranged from 0.165 to 0.203 g. On average, the absolute mass of the right ventricular myocardium was 1560.85 times less than the mass of the animal. Relative mass of the right ventricular myocardium ranged from 0.060 to 0.070 g, which was 1.24 times more than the initial values and 1.16 times less than in the animals of the control group.

On sections of the myocardium of the right ventricle of animals in the experimental group, stained with HBFPA, after 60 days, fuchsinophilic foci were identified that formed large formations. Venous congestion was moderately expressed (Fig. 12).

Conclusions. The results of the experiment show that in animals of the control group during the formation of experimental diabetes mellitus and in animals of the experimental group against the background of selenium administration, the absolute mass of the left and right ventricles depended on the exposure change in the body weight of the animal. In parallel, there was a change in the relative mass of the myocardium of the left and right ventricles. The ratio of the myocardial mass of the left ventricle or right ventricle to the body mass of rats in the control and experimental groups was inversely proportional.

The relative mass of the left ventricular myocardium after completion of the experiment in animals of the control group was 0.043 ± 0.004 g greater than the initial value, and the relative mass of the right ventricular myocardium was 0.032 ± 0.004 g greater than the initial value.

In animals of the experimental group, against the background of selenium administration, the relative mass of the left ventricular myocardium after completion of the experiment was 0.021 ± 0.002 g greater than the initial value, and the relative mass of the right ventricular myocardium was 0.012 ± 0.001 g greater than the initial value.

Analysis of the above data indicates an increase in the mass of the myocardium of the ventricles of the heart during the development of experimental diabetes mellitus both in the control group and in the experimental group against the background of selenium administration. However, in the animals of the experimental group, the increase in myocardial
mass was less pronounced compared to the control group.

The development of myocardial hypertrophy of the ventricles of the heart is possibly a consequence of its increased work during the formation of diabetes mellitus, which causes myocardial ischemia against the background of venous congestion.

In animals of the control group, the development of experimental diabetes mellitus caused pronounced structural changes in the myocardium. In animals of the experimental group, the development of diabetes mellitus against the background of selenium administration did not reveal any pronounced changes in the histostructure of the myocardium.

Thus, our studies suggest that alkylselenonaphthyridine may have a positive effect on the adaptation of the ventricular myocardium to the formation of experimental diabetes mellitus.

References:


