Thymus Recovery after Intensive Physical Exercise under Conditions of Immunocorrection and without It

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Exogenous antioxidants, *e.g.* tocopherol, prevent undesirable changes in the thymus and accelerate its recovery after intensive physical exercise. Four weeks after the end of training (swimming) the general structure of the thymus and content of LPO products in rats treated with tocopherol corresponded to the control values, in contrast to animals receiving no correction.

Key Words: *thymus; recovery; tocopherol*

Immunomodulators are perspective agents improving organism's resistance to adverse exposure. Today drugs inhibiting LPO play a special role in pharmacological rehabilitation of athletes [2-7]. We studied the dynamics of recovery processes in the thymus during tocopherol treatment after intensive exercise.

MATERIALS AND METHODS

The study was carried out on 3-month-old outbred male albino rats (n=75), 60 of which were daily subjected to exercise (forced swimming) for 5 weeks. The initial duration of swimming was 5 min/day; every week it was prolonged by 5 min. Hence, the total duration of exercise was 450 min. Intact control group consisted of 15 rats.

After training 20 rats were decapitated, others were kept without exercise (swimming) under standard vivarium conditions. Of these, 20 animals received 10% tocopherol solution (2 mg/100 g) as an immunostimulatory and antioxidant agent daily for 2 weeks of the rehabilitation period. The animals were sacrificed 2 and 4 weeks after the end of training. Control animals were sacrificed together with experimental at all terms.

The thymus was removed, weighed on torsion scales, and the absolute and relative weights of the organ were determined. Standard histological and morphometric methods were used. Biochemical parameters of LPO were evaluated. Blood from the aorta was collected during sacrifice, centrifuged, and MDA content was determined by the TBA test [1].

The data were processed using Statistica software. The significance of data was evaluated using Student's t test. The differences were considered significant at $p<0.05$.

RESULTS

Significant involution changes were detected in thymuses of trained rats: decreased weight of the organ, disordered structure, adipose tissue growth, decreased count of lymphoid cells, and increased destruction. Two weeks after the end of training, reparative processes were observed in thymuses of rats receiving tocopherol, in contrast to those receiving no correction: organ weight increased, it regained its lobular structure (though the lobules were small), the interface between the cortical matter and medulla in lobules was clear-cut, the area of thymic parenchyma increased, and the percentage of adipose tissue decreased. However, the area

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of the capsule was 1.5 times larger, that of the medulla 1.1 times lower, and of adipose tissue 2.5 times larger than in the control. Analysis of cytological profile of the thymus in animals receiving no correction after training and in those treated with tocopherol indicates that changes in the ratio of cell proliferation/death processes were opposite: destructive processes predominated in the former case, while in the latter group proliferation was increased against the background of less pronounced destruction of lymphocytes in all zones of the thymus (Table 1). An important difference was less pronounced plasma cell reaction in the thymus of animals treated with tocopherol during the rehabilitation period compared to untreated controls.

The count of epithelioreticulocytes in the subcapsular zone increased 1.6 times, of macrophages 1.7 times, and of dying cells 3.8 times, while the count of medium-sized lymphocytes decreased 1.4 times in the tocopherol group in comparison with the control. In the central zone of the cortex the count of mitotically dividing cells decreased and the counts of dying and plasma cells, as well as of macrophages, increased. The number of mitoses increased in the medulla.

After 4 weeks regeneration processes progressed; the weight of the thymus reached the control level, but such structural components as the area of the medulla and percentage of adipose tissue still differed from the control. The areas occupied by the medulla and adipose tissue were below the corresponding parameters in the control by 1.1 and 1.8 times, respectively. However, the total area of the parenchyma virtually did not differ from the control parameters. The area of the parenchyma in animals treated with tocopherol increased at the expense of the cortical matter, while the area occupied by interlobular septae and adipose tissue was significantly less in comparison with rats recovering without correction. The only difference in the cytoarchitectonics of rat thymus in the tocopherol group compared to control animals was a slight increase in the percentage of plasma cells and decreased level of destructions. The content of lymphoid cells in animals treated with tocopherol was increased in all zones, the number of mitoses increased, and the counts of epithelioreticulocytes, plasma cells, and dying cells decreased in comparison with animals recovering without correction.

In contrast to rats receiving no correction, the structure of the thymus in general in animals treated with tocopherol corresponded to the organ structure in control animals; involution signs in the organ were less pronounced.

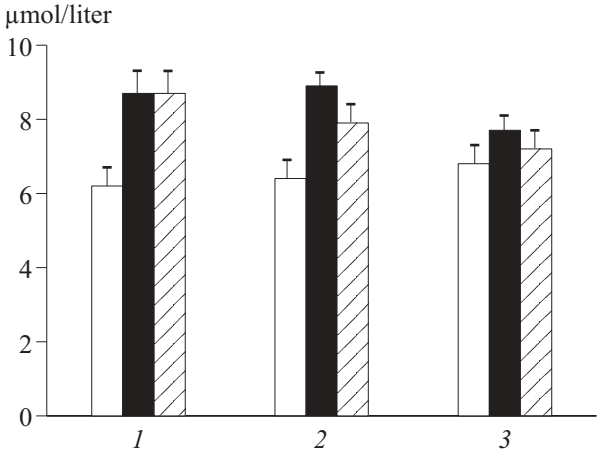

Fig. 1. MDA content in rats during rehabilitation after exercise. *1*) end of training; *2*) 2 weeks after training; *3*) 4 weeks after training. Light bars: control; dark bars: rehabilitation without correction; cross-hatched bars: rehabilitation+vitamin E.

TABLE 1. Percentage of Cells in the Central Zone of the Cortical Matter of the Thymus in Albino Rats during Recovery after Exercise ($x \pm S_x$; %)

Cells	After 2 weeks			After 4 weeks		
	control	no correction	tocopherol	control	no correction	tocopherol
Blasts and large lymphocytes	8.10±1.02	5.00±1.11*	7.50±1.03*	7.50±0.53	5.60±0.78*	8.50±0.67
Medium lymphocytes	20.10±2.54	14.90±1.47*	16.90±1.86	20.20±1.39	30.90±1.82*	19.20±1.48
Minor lymphocytes	58.30±3.42	53.10±3.86	56.80±3.41	58.70±3.28	35.70±9.23*	57.80±3.45
Mature plasmacytes	—	5.90±1.12*	—	—	4.30±1.12*	0.90±0.18*
Immature plasmacytes	—	1.10±0.09*	—	—	0.90±0.32*	0.60±0.02*
Epithelioreticulocytes	10.30±1.25	15.00±1.64*	12.80±1.36	10.20±1.12	16.70±4.12*	9.80±1.65
Macrophages	1.10±0.37	1.70±0.25	3.00±1.18	1.60±0.01	3.80±0.57*	1.80±0.15
Dividing	1.20±0.12	0.20±0.03*	0.50±0.01*	1.00±0.05	0.20±0.06*	0.80±0.02
Destructively changed	0.90±0.03	3.10±0.67*	2.50±0.93*	0.80±0.01	1.90±0.25*	0.60±0.04

Note. *$p<0.05$ compared to the control. "—": not determined.

According to biochemical analysis of the blood, after exercise the content of MDA increased 1.4 times compared to the control and reached 8.7±0.2 μmol/liter. Two weeks after training MDA level remained high in animals receiving no correction; after 4 weeks the parameter still did not reach the control level. In animals treated with tocopherol the content of MDA decreased 2 weeks after the end of training, but still surpassed the control; after 4 weeks it was virtually the same as in the control (Fig. 1).

Increased LPO activity can be damaging for cell membranes: lipid layers of cell membranes are impaired, which disorders cellular activity. Increased content of LPO products is associated with intensification of destructive processes in the thymus and decrease in its weight. Negative correlations between thymus weight and blood MDA levels were detected (r=-0.375, p=0.05).

Hence, tocopherol treatment prevents untoward changes in the thymus and stimulated its recovery after the end of training.

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