MICROBIOLOGY AND IMMUNOLOGY

Cellular Composition of the Lymphoid Tissue of Splenic Structural Components in Mice during Exercise

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Experiments with BALB/c mice demonstrated that dosed exercise (swimming) induced changes at the organ and tissue level indicative of weakening of the immunity system. Changes in the cytoarchitectonics of various structural components of the spleen point to a more intensive development of the adaptation processes during vigorous exercise in comparison with moderate exercise

Key Words: *physical factors; lymphoid tissue*

Exercise is known to cause variously directed effects in the response of the organism. In some cases there may be strengthening of the immunological status and of the adaptation of the organism [6,10,11], while in others there may be depression of the specific defense systems [1,4,8,9]. However, despite numerous experimental data on this topic, the morphofunctional status of the immune system organs during exercise at the microanatomical level has hardly been discussed in the Russian or Western literature.

The aim of our investigation was to elucidate the effects of exercise of various intensity on the lymphoid complex of murine spleen. With this in view, we examined the initial cytoarchitectonics and restructuring of tissue in the case of dosed (moderate and vigorous) physical exertion caused by swimming.

MATERIALS AND METHODS

The central and peripheral zones of the lymphoid nodules and red pulp of the spleen of BALB/c female mice were studied at rest and after exercise. Each group consisted of 7 animals. One group of animals was exposed to moderate sparing exercise: swimming 3 times a day for 6 min (3 min in 28°C water, then 3 min in 38°C water) 4 times a week during 2 weeks. Another group of mice was exposed to intensive exercise: swimming for 30 min a day at 38°C 4 days a week during 2 weeks. The animals were sacrificed by dislocation of the cervical vertebrae.

Fragments of the spleen were fixed in neutral 10% buffered Formalin and embedded in paraffin. Histological slices 4-5 μ thick were stained with azur II-eosin. The cellular composition of structural components of splenic lymphoid tissue was analyzed in 10 visual fields in each functional zone of the organ over an area equal to 880 μ^2. Statistical analysis of the distribution of cellular elements was performed in the absolute and relative percent expression.

RESULTS

The findings indicate that subjecting mice to exercise of various intensity leads to manifest changes in the cytoarchitectonics of the studied functional

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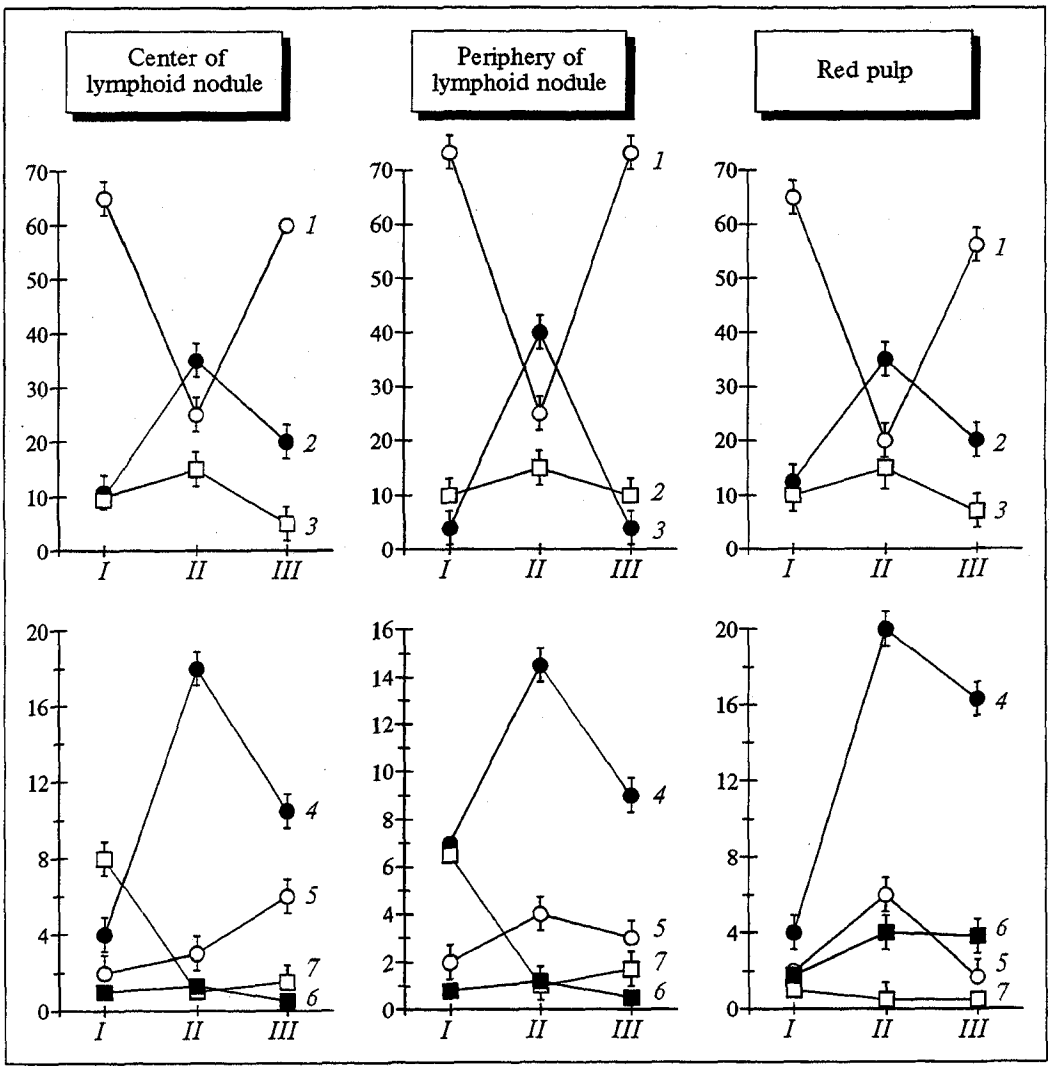

Fig. 1. Cellular composition of structural components of murine spleen in intact animals and animals subjected to exercise, %. Abscissa: exercise: *I*) intact control; *II*) moderate; *III*) intensive. *1*) small lymphocytes; *2*) reticular cells; *3*) medium lymphocytes; *4*) destructively altered and destroyed cells; *5*) macrophages; *6*) neutrophils; *7*) plasmacytes. Ordinate: Percent share of cellular elements.

zones of murine spleen. A similar time course of changes in the percent ratio of the cells in structural components of splenic lymphoid tissue was observed in all the animals subjected to similar exercise in comparison with the control. The most intensive changes in the cellular composition of the lymphoid tissue were observed during moderately intensive exercise. This experiment clearly demonstrated a reduction of the lymphocyte count in the whole organ, the count of small lymphocytes being reduced more than 2.5-fold (Fig. 1). This was paralleled by an increase in the share of stromal reticular cells, due to "denudation" of the reticular skeleton of the organ.

Local peculiarities in the reaction of lymphoid structures are clearly seen during exercise. A reduced count of small lymphocytes under conditions of moderate exercise is observed in the peripheral zone of the lymphoid nodule, particularly in the red pulp. In the central zone of the nodule the processes of destruction and degradation of cells are drastically intensified (Fig. 1). The incidence of large macrophages with cellular detritus in the organ parenchyma is increased.

Comparatively high counts of lymphocytes, approaching the initial level in all the structural components of the organ, are observed during vigorous exercise. A trend toward increased mitotic activity of the cells in the central zone of the nodules was observed in both experiments. It was paralleled by a marked increase of cell differentiation, expressed in an increase in the number of large lymphocytes. The counts of these cells during moderate and vigorous exercise increased 11- and 1.5-fold, respectively.

In contrast to lymphoid nodules, the red pulp of the spleen is characterized by the greatest variety of cellular elements. Besides the lymphoid elements, a significant role in cellular cooperation is played by the granulocytic cells, mainly neutrophils, whose counts reliably increased in both experiments. For the first time during the experiment

mast cells appear in this structure; megakaryocyte accumulations are observed, localized mainly in the subcapsular zone of the organ. Macrophagal counts increase and plasmacyte counts decrease in the red pulp to a much greater degree than in the white pulp. Blasts and large lymphocytes are virtually undetectable in the visual field of the organ slice.

Investigations at the organ and tissue level demonstrated that moderate and vigorous exercise, though causing no apparent morphological changes in the organ, significantly alter the cytological profile of the white and red pulp. This appears to be primarily due to massive destruction of small lymphocytes. According to published data, in athletes exercise similarly leads to a decrease of the blood lymphocyte counts [3,5,9,10] and frequently becomes the cause of the development of autoimmune and allergic disorders [2,7]. It is natural to assume that such a severe depletion of immunocompetent cells, reflecting general processes taking place in the body, will go along with impairment of the defense mechanisms in the experimental animals.

Moderate exercise, leading to intensive destruction of cells, lends a strong boost to cell multiplication, as is proved by an increase in the fraction of little-differentiated cells and cells in a state of mitosis. This, along with a denser arrangement of the reticular cells, is responsible for an increase in the concentration of cells per unit area in the central zones of the lymphoid nodules in this experiment.

During vigorous exercise the values of cellular degradation are lower, even in comparison with the control, which may be due to a somewhat higher content of macrophages and their increased activity. The data indicating a high concentration of small lymphocytes in the mantle (peripheral) zone of the lymphoid nodules and in the red pulp during vigorous in comparison with moderate exercise are explained by enhanced circulation of lymphocytes and their "settling" in the corresponding structures of the spleen.

Hence, analysis of the findings demonstrated that exposure of mice to moderate and intensive exercise is associated with signs of deterioration of their immune reactivity (marked reduction in the counts of plasmacytes and small lymphocytes and a high level of cell degradation). This is paralleled by the development of adaptation to the unaccustomed exercise in the spleen of both groups. On the whole, these processes in the spleen are expressed in increased cellular dedifferentiation and activation of mitotic activity. The adaptation processes developed more intensively in the group of animals subjected to more vigorous exercise than in animals which exercised less intensively. This is confirmed by the development of reactive centers in the lymphoid nodules of the organ characterized by higher counts of large lymphocytes and macrophages than in the control and by an increase of the cell concentration at the periphery of the nodule, as well as by a percent share of small lymphocytes and other cells close to the baseline level.

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