Morphofunctional Transformations in the Thymus and Lymph Nodes After Irradiation with a Helium-Neon Laser

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Morphological transformations occurring in the thymus and lymph nodes are studied in Wistar rats after irradiation of the thymus projection area and transcutaneous irradiation of peripheral blood with a low-energy helium-neon laser during a 7-day period. Irradiation of the thymus projection area stimulates lymphopoiesis in T-dependent zones of lymph nodes, while irradiation of peripheral blood increases lymph flow through lymph node parenchyma and activates B-dependent zones.

Key Words: *low-energy laser radiation; thymus; lymph nodes*

In the recent decade, the search for morphological indicators of the tolerated dose of laser radiation has been intensified. Application of a low-energy helium-neon laser (HNL) is prospective for correction of immune disorders. It was demonstrated that irradiation of the thymus and spleen projections with an infrared laser change immunoreactivity of laboratory animals [5]. It was reported that HNL induces myelo- and lymphopoiesis in the spleen and stimulates humoral immunity [6].

In the present study we examined morphological changes in the thymus and lymph nodes induced by HNL radiation.

MATERIALS AND METHODS

Experiments were performed on male Wistar rats aged 2.5-3 months. The irradiated areas were thoroughly shaved. The thymus projection area and femoral artery and vein were irradiated with a HNL (wavelength 632 nm, 25 mW/cm, 10 min, 7 sessions). Thymus and ileal lymph nodes were incised 24 h after the last irradiation session, processed by standard histological methods, embedded in paraffin, and 5-7-μ section were cut. The sections were stained with hematoxylin-eosin and azure II-eosin [7]. Morphometric parameters were determined using the microscope ocular; cells in various zones of the thymus and lymph nodes were counted. The results were analyzed using Student's *t* test.

RESULTS

After irradiation of the thymus projection area with HNL, cortical zone of the thymus decreased by 12.0±0.71%, while medullar zone increased by 5.86± 0.08% compared with the control. The relative area of the connective tissue elements increased by 69.0± 1.08%, which was caused by the capsule loosening and edema. The number of lymphoblasts in subcapsular cortical tissue increased 7.57-fold, in the central cortical tissue 14.54-fold, in the intermediate zone 23.04-fold, and in the medullar tissue 2.7 fold. A considerable increase in the number of mitotic cells and in the number of medium lymphocytes was observed in all zones with the exception of the cortico-medullar zone. In the subcapsular zone the number of small lymphocytes decreased by 80.0±2.98%, in

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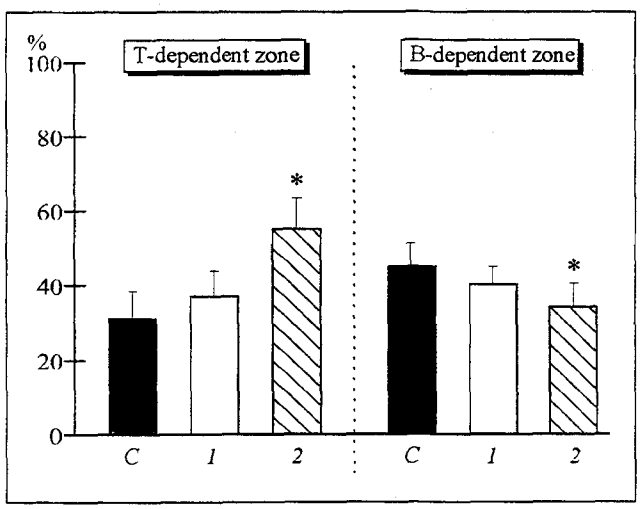

Fig. 1. Relative sizes of T- and B-dependent zones of rat ileal lymph nodes after laser irradiation of the thymus projection area (*2*) and transcutaneous irradiation of femoral neurovascular bundle (*1*). *C*) intact animals. Here and in Fig. 2: 100% is the area of median section of a lymph node; *$p<0.05$ compared with intact animals.

the central cortical tissue by 67.0±2.42%, in the intermediate zone by 71.2±2.68%, in the medullar tissue by 10.0±0.69%. The number of macrophages in the cortical tissue increased by 80.0±3.12%. After transcutaneous irradiation of peripheral blood, the area occupied by cortical tissue was practically the same as in intact rats, while the relative area of medullar tissue decreased by 8.9±0.38%. The area occupied by the connective tissue increased by 33.8± 1.49% primarily due to edema and loosening of the trabeculae and capsula. Changes in the thymus were similar to those observed after irradiation of thymus projection, but their intensity was lower. It should be noted that after irradiation of peripheral blood the

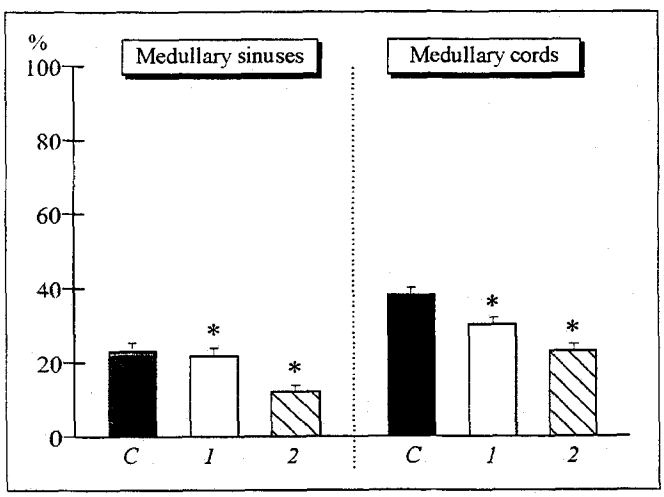

Fig. 2. Relative sizes of medullary sinuses and medullary cords in ileal lymph nodes after laser irradiation of thymic projection on the skin (*2*) and transcutaneous irradiation of the femoral neurovascular bundle (*1*). *C*) intact animals.

number of macrophages in thymic medulla decreased by 14.3±1.12% compared with intact rats, while the number of neutrophils increased 7.87-fold, and the number of monocytes also increased.

After irradiation of the thymus projection, the area occupied by cortical tissue in the ileal lymph nodes increased by 68.0±2.43% compared with intact animals, while that occupied by medullar tissue decreased by 45.0±1.62%. The corticomedullar index of 2.02 indicated that these lymph nodes are of the compact type [2]. An increase in the cortical area resulted primarily from an increase in the paracortical (T-dependent) zone (Fig. 1). The relative area of the capsule decreased, while that of marginal sinus increased. The relative size of medullary sinuses and cords decreased considerably (Fig. 2). The total area of B-dependent zones decreased compared with the control (Fig. 2). After transcutaneous irradiation of peripheral blood with HNL, the area occupied by cortical tissue in the ileal lymph nodes increased to a lesser extent (by 22.8±2.04%), while that occupied by medullar tissue decreased by 6.4±0.59% compared with the same parameters after irradiation of thymus projection. The corticomedullar index was equal to 0.96, indicating that these lymph nodes belong to the intermediate type [2]. In this case an increase of the medullar area resulted primarily from an increase in the area of secondary lymphatic noduli by 51.85± 2.48% and of paracortical zone by 19.0±1.22%. The size of medullary sinuses decreased in comparison with intact animals, but to a smaller degree than after irradiation of the thymus projection. The relative area of the marginal sinus increased compared with the control and irradiation of thymus projection.

From our results it can be concluded that:

1) Irradiation of the thymus projection area with a HNL for 7 days activates proliferation of both cortical and medullar zones of the thymus. An increase in the number of medullar macrophages can be regarded as a positive tendency, since these cells play an important role in antigen-independent differentiation of thymic lymphocytes [3,8]. This mode of irradiation changes the functional type of ileal lymph nodes from fragmental to compact. In lymph nodes, an increase of the area occupied by cortical tissue is due primarily to an increase in the area of T-dependent zone.

2) Modifications induced in the thymic cytoarchitectonics by transcutaneous irradiation of peripheral blood were less pronounced than those observed after irradiation of thymic projection. Presumably, laser radiation markedly increases vascular permeability [4], which leads to a rise in the number of neutrophils and monocytes in thymic medulla. An increase in the area occupied by cortical tissue in

lymph nodes is due to an increase both in T- and B-dependent zones. An intermediate type of a lymph node structure and widening of marginal sinus suggest that laser irradiation of peripheral blood increases lymph flow through the nodes.

Our data suggest that various modes of laser irradiation modify various functions of lymphatic system. For example, lymphopoiesis in T-dependent zones can be stimulated by irradiating the thymus projection area. Laser irradiation of peripheral blood increases lymph flow though lymph nodes and, consequently, the flow of antigenic information and activates B-dependent zones similar to endolymphatic irradiation of the central lymph [1]. Activation of humoral immunity is associated not only with increased flow of antigenic information but also with a more potent response of lymphoid tissue to antigenic load [6].

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