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STRUCTURAL AND FUNCTIONAL REACTIONS OF LYMPH NODES TO VARIOUS ANTIGENIC EFFECTS

Khasanov Bakhtiyor Burtkhanovich
Bukhara Medical Institute, Bukhara, Uzbekistan

Annotation.
The article is devoted to a review of the literature on intercellular relationships occurring in the lymph nodes during the immune response. Peculiarities of intercellular relationships during the immune response in response to exposure to an antigen.

Key words: lymph node, stroma, antigen, T-cell and B-cell immune responses, stromal cells, lymphoid cells, intercellular cooperation.

Relevance. The lymph node is one of the sources of antibody production in mammals, which determines its important role in antigenic effects [9, 10, 11, 12].

At present, a certain number of works have been accumulated on the structural and functional features of the reactions of lymph nodes to antigenic effects of bacterial or other origin. These works mainly reflect the responses of the lymph nodes of adult animals to various antigenic effects, while the features of postnatal ontogeny of the lymph nodes under conditions of antigenic effects remain unclear [13-15].

Structural changes that occur in all peripheral lymphoid organs in response to antigenic exposure are in principle identical, but the degree of involvement of one or another organ in the process depends on the site of penetration and the nature of the antigen - the primary affect [1, 4, 7].

The initial stage after the penetration of substances foreign to the body is their recognition by T-lymphocytes, which, when migrating to the zone of primary affect, either destroy them or react with them by producing soluble factors [2, 13].

Studies by a number of authors have shown that with age there is a decrease in the proliferative response of lymphocytes to various mitogens. During immunization of newborn rat pups, the first antibodies are detected on the 5th day after birth [2, 3, 15]. The appearance of antibodies in the blood is preceded by a certain, so-called latent period, during which the blast transformation of B-lymphocytes into plasma cells occurs. The duration of this period depends on many factors, such as the immunogenicity of the antigen, the degree of maturity of the lymphoid organs, and the age of the macroorganism.

Some authors [4, 5] argue that when an antigen appears in the fetus, the accelerated development and differentiation of lymphoid tissue is clearly stated, which is documented by the formation of follicles in the lymph nodes, in which germinal centers (GCs) are detected during infectious diseases. The latter develop only under the influence of antigenic stimulation [9, 10]. Similar results were obtained in an in vitro experiment [12]. When the supply of the antigen with the lymph stops, the size of the HC gradually decreases and after 15 days they disappear, and the population of small lymphocytes in the corona is greatly depleted [7, 9]. In addition to the presence of B-lymphocytes and antigen, the formation of HC requires the participation of T-cells of the CD4+ phenotype, plasma cells, and non-lymphoid cells. Only with the interaction of these cells begins the development of HC in the follicles. It is also necessary to involve cells specific for HC, such as macrophages [17]. Non-lymphoid cells are

involved in the processing of antigenic material [18].

Antigen from tissues reaches HC either in free form, with lymph flow, or is transported by macrophages [39]. Pseudopodia of antigen-bearing macrophages come into contact with FDC processes, and the transfer of the antigen-antibody complex (AG-AT) occurs in a conveyor way from cell to cell.

Macrophages in the marginal zone present antigen to cortical lymphocytes. B-lymphocytes of the marginal zone bind non-phagocytosed material through Fc-, C3 and S-receptors and carry it towards the follicle [48]. Depletion of the B-lymphocyte population in the marginal zone leads to a decrease in the amount of antigen in the lymphatic follicle, sometimes to complete absence [38].

Dendritic cells play an equally important role in the process of immune response induction. During immunogenesis, follicular dendritic cells (FDCs) present antigen to B cells with appropriate receptors, which adhere tightly to their immune complex-bearing dendrites [48]. Having received an antigenic stimulus, such B-lymphocytes transform into blasts and begin to proliferate, which is accompanied by a change in the set of surface markers. These processes are carried out within the GC, where without a sufficient number of T-helpers, antigen-activated B cells do not turn into antibody-forming cells, but go into a resting state [49].

Dendritic cells are the main antigen-presenting cells in the primary immune response. For the development of a secondary immune response in vitro, 10 times fewer dendritic cells are sufficient [50].

So, the main antigen-presenting cells can be macrophages, dendritic cells, B-lymphocytes of the marginal zone, memory B-cells. All antigen-presenting cells carry Ia antigens, which play a leading role in the process of cell interaction in the immune response. They are necessary for the activation of T-helpers, for the transformation of killer precursors into mature cells - effectors.

Thus, the analysis of literature data shows that there are a significant number of works devoted to intercellular interactions of immunocompetent cells of lymph nodes during antigenic exposure. At the same time, studies on the response of lymph nodes to antigenic effects in early postnatal ontogenesis are few and contradictory.

In the formation of the immune system of newborns, an important role is played by mother's milk, which contains a large number of immunocompetent cells that enter the body of newborns along with milk, and create adaptive immunity. According to the data obtained by our preliminary studies [6, 21, 22, 23, 26, 28-31, 40-43, 47, 54, 66, 69], during pregnancy and lactation, the mammary gland undergoes structural changes associated with the specialization of the organ for milk production and transfer of biologically active substances, protective components and immunocompetent cells of the mother to newborns [15, 16, 19, 20, 24, 25, 32-34, 35-37, 44-46, 51-53, 55-58, 59, 60, 67]. In addition, the formation of the immune organs of newborns in postnatal ontogenesis is influenced by environmental antigens and microelements supplied with food. Thus, the results of studies by a number of authors have shown that the level of cells producing antibodies decreases when subacute doses of T-2 toxin are added to food [13, 14]. The authors suggest that this is due to damage to the function of helper T cells involved in the generation of antibody-forming cells. In addition, the composition of the food consumed also affects anti-infective protection. When feeding chickens and pigs with poor-quality and infected food, an absolute increase in the weight of the bag of Fabricius, spleen and liver was noted [15, 16, 17, 18]. At the same time, a significant decrease in the absolute and relative number of lymphocytes was revealed in the spleen and bursa of Fabricius.

As is known, 3 types of cells are involved in the development of the primary immune response: T- and B-lymphocytes, and A-cells, the action of which is genetically restricted [63]. The mechanism of interaction between an antigen and a lymphocyte is unclear, but it is assumed that this process is multistage and is closely associated with the surface structures of lymphocytes - receptors. In the

process of antigen recognition by lymphocytes, the antigen-receptor complex is redistributed, which is regulated by the genetic apparatus of the cell and is a phylogenetically ancient form of antigen recognition [65]. Nevertheless, studies by a number of authors show that macrophages are the first barrier to entry of antigenic substances into the body [48]. The involvement of macrophages in immune defense begins with antigen binding. The mechanism of this process is carried out in the form of passive adsorption, phagocytosis and pinocytosis, after which 90% of the antigens are destroyed, and the rest of it is destroyed, and the rest of it, being destroyed to antigenic determinants, is exocytated on the cell surface [46, 68]. Similar data were obtained by other authors, who indicate that, along with the ability to phagocytize pathogenic antigens, macrophages play an important role in a specific immune response: they determine antigenic peptides resulting from limited antigen proteolysis [63, 65]. In addition, macrophages regulate the activity of lymphocytes for various mediators and cytokines produced spontaneously or after activation. Along with this, a necessary condition for the development of most immune responses is the participation of macrophages in cooperative interaction with immunocompetent cells [61, 62, 64]. Thus, the analysis of the literature data shows that by now the issues of the embryonic development of the lymph nodes have been sufficiently well covered. A certain amount of data has been accumulated on the specific features of the lymph nodes in the process of embryonic development of the lymph nodes, on the temporal parameters of the formation of its structural and functional zones. There are reports that give the structural basis for the participation of lymph nodes in various immune responses and maintaining the body's immune homeostasis.

At the same time, many questions of the structural foundations of the formation of lymph nodes in early postnatal ontogenesis are still far from final resolution. In particular, the quantitative relationships of various structural components of the lymph nodes in the dynamics of postnatal development and during antigenic exposure remain unexplored. The issues of proliferative activity during the periods of formation of structural and functional zones of lymph nodes in the dynamics of early postnatal ontogenesis in the norm and under conditions of antigenic exposure have not been clarified. These questions formed the basis for the present study.

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