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MODERN CONCEPTS ON THE STRUCTURE OF LYMPH NODES

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Annotation.

The article presents an overview of the latest data on the structural and functional features of the lymph nodes - peripheral organs of the immune system involved in the body's immune response. The morphological and functional features of the zonal structure, features of intercellular relationships are described.

Key words: lymph node, cortical zone, cerebral cords, sinuses, connective tissue stroma of the node.

Relevance. It is known that the formation of the immune system and other systems of the developing organism directly depends on the antenatal and postnatal development of the infant, which are genetically determined processes in which the placenta plays an important role in the dynamics of pregnancy [3, 4, 36], and after childbirth, the mammary gland [22, 26, 27, 28, 29, 47, 52, 58, 60, 63], unfortunately, insignificant effects of adverse environmental factors, deviations in health status, especially pathological changes in the mother's body during pregnancy and lactation are negative affect the development and formation of the internal systems of a developing organism [15-18, 19-21, 23-25, 30-35, 37-40, 41-45, 48-55]. In connection with the rapid development of immunology, there is a refinement of information about the participation of immunocompetent cells in immune responses, and, accordingly, the ways of differentiation of these cells, which is carried out in a specific tissue environment. One of the important organs of the immune system where this occurs is the lymph node [1,2,6,36].

The lymph node is a powerful biological filter that traps various antigens. In the lymph node, intercellular cooperation of immunocompetent cells is carried out during immune reactions of the cellular and humoral type. The role of lymph nodes is especially great in various infectious, allergic and neoplastic diseases. In recent years, the understanding of the structure of the lymph nodes and their various zones has changed significantly and supplemented [7, 36].

According to the latest edition of the international histological nomenclature [2, 7, 36], the cortex is distinguished in the lymph nodes, including the follicles, the paracortical zone, and the medulla with pulpy cords.

However, such a division is no longer enough, since the structure of the paracortical zone is already detailed. In particular, it has been shown that cell populations in its peripheral and deep parts, although morphologically similar, differ in their response to antigenic stimulation [8, 9, 10], and the population density of small lymphocytes is much higher in the peripheral part of the paracortical zone [11, 12]. Therefore, in the cortical substance, peripheral and deep parts are distinguished, differing morphologically and functionally. The peripheral cortex includes lymphatic follicles (primary and secondary) [13, 14], marginal and interfollicular zones.

Primary follicles are round clusters of densely packed small lymphocytes that have undergone antigen-independent differentiation in the bone marrow and lie between follicle-dendritic cells

(FDCs). The phenotype of B-lymphocytes in primary follicles is identical to most blood B-lymphocytes. Reticular cells differ in ultrastructure from FDCs of secondary follicles, in particular, they have poorly developed cytoplasmic processes [15, 16]. Reticular fibers along the periphery of the nodule form a finely looped network [12,14].

In the secondary lymphatic follicle, the crown and the germinal center (GC) are distinguished. The crown consists of concentrically lying small lymphocytes. By immunohistochemical properties, they completely correspond to peripheral blood B-lymphocytes [14]. Macrophages, lymphoblasts and reticular cells are also found here. The crown is asymmetrical. Lymphocytes in the crown have a dual origin: from the bone marrow and from the germinal center. The last population is a recirculating pool of memory B cells [56]. The cellular composition of the various poles of the germinal center is not the same. Taking this into account, its dark zone, consisting mainly of plasmablasts and a small amount of reticular cells, and the light zone, consisting of lymphocytes and FDCs, are distinguished [57].

B-lymphocytes in the germinal center are at different stages of proliferation and differentiation. The latter occurs in two directions: with the formation of a mature plasma cell through immunoblasts, plasmablasts, immature plasma cells, and with the formation of memory B cells. There is evidence that if a B-lymphocyte reaching the germinal center has an incomplete set of markers, then it differentiates into memory B-cells. If the B-lymphocyte was mature before entering the HC, it turns into a plasma cell [1, 3, 7].

The interfollicular zone contains small lymphocytes, macrophages, and fibroblast-like reticular cells (FRCs). The intermediate sinuses pass through it. The population density of small lymphocytes is much higher here than in the deep cortex [7]. The intermediate sinuses pass through it. The population density of small lymphocytes is much higher here than in the deep cortex [36]. FDCs can only be identified by the electron dense cytoplasm and by close association with reticular fibers. The exact function of FDCs is unknown, apparently, they are part of the microcirculation required for optimal functioning of lymphoid cells.

The marginal zone is located in the outer cortex between the marginal sinus and the lymph node [2, 4]. Its stroma is represented by FDC. The network of reticular fibers is much better expressed than in other parts of the lymph node [6]. Middle lymphocytes with Fc receptors are located between the elements of the stroma [7, 8]. The marginal zone, apparently, together with the underlying areas of the marginal sinus endothelium, spontaneously captures from the lymph and leads them to the locations of the cells involved in the development of the immune response [9, 10].

The subcapsular sinus is lined with cells of an endothelial nature [7, 36]. The cells lining the wall of the sinus facing the capsule of the node differ in a number of ultrastructural features from the cells of the opposite wall. This is due to the fact that migration of cellular elements occurs through the intercellular gaps of the latter. There are many active macrophages in its lumen. There are various cells of the lymphoid series, mast, subcapsular, plasma cells, granulocytes. The sinus lumen is traversed by strands or trabeculae consisting of collagen fibers immersed in a low electron density substance and covered from the side of the sinus lumen by lining cells [51]. The sinus lumen is narrower above the nodules, and wider above the internodular zone [7, 36, 52], so the lymph flow here is slower, which contributes to the preferential retention of the antigen by the cells of the marginal zone, above the interfollicular zone of the peripheral cortex. Antigen retention in this area is also facilitated by the presence of a denser network of reticular fibers crossing the subcapsular sinus [1, 7, 10, 11, 36]. Ultrastructural features of the wall of the sinuses contribute to that. That metabolic processes occur through interlittoral fissures in an

intracellular way in two directions [1, 7, 36].

Three-dimensional structural analysis showed that the deep cortex is subdivided into units adjacent to the peripheral part of the cortex. These units are semicircular sections of the structure. The shape of which varies from a hemisphere to a semi-ovoid. The lymph node contains several of these units. Which can merge, forming a complex. Topographic units are associated with the confluence of the afferent lymphatic vessels [1, 2, 10]. In each unit, a center and a periphery are distinguished, differing from each other in morphological properties. The center is almost devoid of reticular fibers, while the network is dense on the periphery [4, 6]. The majority of postcapillary venules are concentrated on the periphery [7, 8, 9]. Both zones mainly contain small lymphocytes [9, 11, 12], but their concentration is lower in the periphery. In the center, the cells linger and proliferate, while in the periphery there is a place of rapid migration of lymphocytes by units into the cerebral sinuses [61]. Near the postcapillary venules in the peripheral part of the deep cortex, a small number of B-lymphocytes were also found. In the deep cortex, all cells of the plasmatic series migrating from the germinal center to the medullary cords can be found. The ratio of cellular forms varies significantly depending on the stage of the immune response; the cellular composition of the complex nodule changes.

In the lymphatic nodule, the so-called complex silt compound nodules are also isolated, consisting of a secondary follicle and an adjacent T-territory. The T-territory of the adjacent nodule is round, contains high endothelial venules, interdigitating reticular cells (IDCs), many helpers, and few T-suppressors. Depending on the type of antigen and the course of the immune response, the cellular composition of the complex nodule changes [61, 62].

The parenchyma of the medulla is represented by accumulations of lymphoid tissue, extending from the internal sections to the chyle. Pulp strands are connected to each other, forming complex weaves. The sinuses are limited to a single layer of cells, with no distinct basement membrane [59]. Some authors distinguish the hemato-tissue barrier in the fleshy cords, represented by the capillary endothelium, the platinum basalis, the precapillary space and a discontinuous layer of reticular cells and their processes. Endothelial cells contain fenestrae and vesicles, the basement membrane is continuous and clearly contoured. Precapillary spaces are adjacent to lymphoid cells, mainly plasmacytes, which ensures the flow of antibodies from plasmacytes into the blood. Sometimes plasmacytes come into contact with processes of reticular cells. On the free surface of the fleshy cords, facing the lymphatic sinuses, the barrier that separates the blood from the lymph is represented by a fenestrated endothelium, a basal plate, a precapillary space, and a layer of coastal cells, among which there are gaps.

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