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THE IMPORTANCE OF MORPHOLOGICAL CHANGES IN THE THYMUS OF YOUNG WHITE RATS

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Abstract

The thymus is the central or primary organ of the lymphoid (immune) system. Its main functions are to ensure the maturation and differentiation of thymocytes, the integration of various populations of thymocytes and macrophages for the implementation of immune responses. The article studies and presents the latest scientific data on the development of the thymus, its structure and cellular composition. Both well-known sources and new literature were used. This article shows the external features of the structure of the thymus, the internal structure, as well as the cellular composition.

Key words: thymus; immune system; morphology; postnatal ontogenesis.

The thymus is the central or primary organ of the lymphoid (immune) system. As is known, its main functions are to ensure the maturation and differentiation of thymocytes, the integration of various populations of thymocytes and macrophages for the implementation of immune responses. The morphofunctional state of the central organ largely determines the activity of secondary (peripheral) structures of immunogenesis and the severity of protective reactions of the whole organism. Currently, knowledge of the structural features of the organs of the immune system and the determination of the beginning of differentiation of immunocompetent cells in different stages of the ante- and postnatal periods of ontogenesis allows us to understand the processes of formation of immunological functions characteristic of these organs.

The aim

of the study was to study the dynamics of the formation of the microanatomic organization of the thymus gland in white rats in the antenatal and early postnatal periods of development. The conducted studies allow us to better understand the patterns of the structure and development of the

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organs of immunogenesis, allowing us to standardize morphological data in the process of physiological ontogenesis. In all mammalian animals, the thymus is located in the mediastinum. In humans, it is located in the anterior part of the upper mediastinum. The body of the sternum, the sterno-hyoid and sterno-thyroid muscles, the parietal pleura are attached to its ventral surface, and the pericardium, trachea, aortic arch, internal jugular and brachiocephalic veins, the recurrent laryngeal nerve are attached to the dorsal surface. In rats, the thymus is localized in the ventral mediastinum. It is well known that the thymus consists of lobes. Back in the XIX century, it was noted that the number of lobes in the human thymus varies from one (when the right and left lobes merge) to five, which was confirmed in the XX century. Nevertheless, it is believed that the main variant of the structure of the human thymus is its two-lobed organization. In rats, the thymus consisting of two lobes is also most common. At the same time, in adult rats, in 4.3% of cases, a thymus consisting of three lobes was detected, and in newborn rats, such a variant of the organ structure was found in almost 21.8% of observations.

Like all parenchymal organs, the thymus is covered with a connective tissue capsule. The septa extending from it reach the boundary between the cortical and cerebral substance and divide the parenchyma into lobules of various sizes. Vessels and nerves pass through these partitions. Traditionally, two parts are distinguished in the thymus lobule: the cortical substance (cortex) is dark, with a dense arrangement of lymphoid cells (thymocytes) and the medulla is lighter, in which there are significantly fewer thymocytes, but reticular epithelial cells are well defined; thymus corpuscles are also detected here. 90% of the cellular composition of the thymus is represented by thymocytes. There is no consensus in the literature on structurally functional zones in the thymus lobules. Some authors distinguish four zones within the lobule: 1 — external subcapsular zone, 2 — internal cortical zone, 3 — medulla, 4 — perivascular connective tissue [1], others describe three zones: cortical, cortical-cerebral and cerebral [2]. Some authors define four zones in the thymus lobule: subcapsular, internal cortical, medullary (medulla) and intra-lobular perivascular spaces. However, in later studies, five zones began to be distinguished in the thymus lobule: three in the cortical substance (subcapsular, central cortical zone and borderline with the medulla) and two in the medulla (borderline with the cortex, and central) [3]. The subcapsular zone of the cortex is formed by a network of epithelial reticulocytes. The cells of this network contain pretimocytes, lymphoblasts and a small number of macrophages [4]. In this department, under the conditions of a specific microenvironment, proliferation is carried out and the initial stages of maturation of the pretymocytes that immigrated here from the bone marrow take place. Antigen-independent differentiation of thymocytes ends in the inner cortical zone, which is formed by a broad-leaf network of reticular epitheliocytes, selection and elimination of autoaggressive thymocytes are carried out, and mature autotolerant cells migrate

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to the medulla or exit the thymus in the cortical-medullary zone [5]. Thymocytes of the inner cortical zone account for up to 80% of all thymus a lymphocytes and are characterized by the presence of T10, CD2, CD5, CD7, CD1, CD3, CD4 and CD8 antigens [6]. Antigen-dependent maturation of thymocytes is carried out in the thymus medulla. This zone is formed by a dense network of epithelial reticulocytes, and its cells are small in size. Thymus corpuscles are also determined here. Thymocytes of this zone have the morphology of medium and small lymphocytes, have a high degree of differentiation, the ability to blasttransformation reaction, they have antigenic signs of helpers, killers and suppressors. From here they enter the bloodstream and thymus-dependent zones of the secondary organs of the immune system [7]. The thymus corpuscles (TT) defined in the medulla are formed from overlapping reticular epithelial cells (RE) with hyaline grains in the cytoplasm and dystrophically altered nuclei. Further, necrosis and calcification of the center of the forming thymus body sequentially occur. TT can be determined even after the complete replacement of the thymus lobule with adipose tissue [8]. There is an opinion that TT serve as stimuli for RE and cause accelerated proliferation, an increase in the size of the thymus and its colonization by lymphocytes [9]. In addition to thymocytes of varying degrees of maturity and RE, the cellular composition of the thymus includes interdigitating cells with phagocytic activity and probably providing antigens to thymocytes and activating lymphocytes at rest. Mast cells, granulocytes, plasmocytes, cells of the APUD system can be identified in the thymus, and basophils can be identified in the interlobular connective tissue [10]. The formation of the thymus in ontogenesis occurs earlier than other organs of the lymphoid system and endocrine glands. In humans, the rudiment of an organ in the form of paired epithelial strands is revealed at the 4th week of intrauterine development [11]. In the early stages of development, paired strands of multilayer epithelium surround mesenchymal cells that migrate, as it is believed, from the neural crest. From these cells, the capsule, interlobular septa and reticular tissue of the thymus develop [12]. At the initial stage of development, the epithelial rudiment of the thymus in the cervical part has a lumen — the thymopharyngeal duct, which subsequently, as a rule, undergoes obliteration. In rats, the epithelial rudiments of the thymus, located on the sides of the pharynx, are detected on the 12th-13th day of intrauterine development, and this period is defined as the period of "dense rudiment" [4, 13], which subsequently, as a rule, undergoes obliteration. In rats, the epithelial rudiments of the thymus, located on the sides of the pharynx, are detected on the 12th-13th day of intrauterine development, and this period is defined as the period of "dense rudiment" [13]. Further, during the 14-16 days of prenatal ontogenesis, mesenchyme and blood vessels are introduced into the epithelial lining of the organ, RE differentiation occurs and the organ is populated with lymphocytes [4]. During the 17-19 days of intrauterine development of the thymus, its capsule, interlobular septa, lobules, intraorgan vascular bed and subcapsular zone are formed. By

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the time of birth, the formation of thymus lobules continues, the differentiation of parenchyma into cortex and medulla. The first lymphoid cells in the epithelial rudiment of the rat thymus are detected on the 14th day of intrauterine development. Initially, the cellular composition of the thymus is characterized by a large number of RE and lymphoblasts, and the content of medium and small lymphocytes is low. By the time of birth, the number of small and medium lymphocytes increases, a well-formed subcapsular zone consisting of 5-6 rows of cells is determined, mast cells appear in perivascular spaces and interlobular connective tissue [13]. During the first month of postnatal life in the thymus of rats, the process of formation of new lobules slows down. The subcapsular zone is preserved only at the top of the lobules, and the rest of the length is populated by small lymphocytes and disappears. In the lobules of the organ, the growth of brain matter continues, in which TT is formed, their small amount is a specific feature of rats [2]. After birth, both in the cortical substance and in the medulla, the number of small lymphocytes increases, and medium and lymphoblasts decrease [4, 13, 14]. Thus, the formation of the main structures of the thymus occurs in humans at the 17th week of intrauterine development, and in rats it continues in the postnatal period of ontogenesis.

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