Changes in the Thymus, Spleen and Lymphodic System Under the Influence of Various Factors

Ashurov T.Kh Bukhara State Medical Institute

ABSTRACT

Present article is devoted to the peculiarities of the structure and function, morphometric parameters of the basic structures of the central and peripheral organs of the immune system. It reveals the patterns of the development of these organs at different stages of postnatal ontogenesis. The data of the domestic and foreign literature on the impact of environmental factors on the structural changes in the thymus and spleen on the organ, tissue and cellular levels was analyzed. Further study of the morphological and functional organization of organs of the immune system will allow to identify and analyze the patterns of their structural and functional changes influenced by the factors of different origin.

Keywords: morphology, organs of the immune system, thymus, spleen, the effect of environmental factors.

The immune system of humans and animals is one of the most reactive systems of the body, quickly responding to the effects of damaging factors at the earliest stages. The immune system is formed by a complex of organs and tissues that create protection against foreign endo and exogenous influences [4,8]. It arose in the early stages of evolution, and its activity is based on the recognition of foreign antigens, their destruction and removal, which is absolutely necessary for the survival of the organism [2]. There is now strong evidence that the immune system largely determines the body's resistance to chemical factors. The central organs of mammalian immunogenesis are the thymus, where T-lymphocytes are formed and multiply, and the red bone marrow, where B-lymphocytes are formed and multiply. Peripheral lymphoid organs are lymph nodes, spleen, tonsils, and intestinal lymphoid follicles [6,7,12].

Lymphoid tissue, which is the main site for the development of specific immunological reactions, contains numerous populations of cells involved in ensuring the genetic constancy of the internal environment of the body [10]. In this case, the thymus is considered as an immune organ in which acquired and natural immunity is formed with the help of biologically active peptides [16,18]. The history of studying the structural organization and functions of the thymus gland (thymus, lymphatic, goiter, large thoracic node) goes back many decades [19]. In the structure of the immune system, the thymus ensures the maturation and differentiation of T-lymphocytes, including those in peripheral immune organs, and stimulates the integration of various populations of T-lymphocytes and macrophages to implement immune responses [22].

Until the end of the 20th century, the theory of involution of the human and animal thymus was considered undeniable. According to the theory of thymus involution in adolescents 14-15 years old and animals aged 8-9 months . with the achievement of puberty, the organ under study undergoes complete involution in the body and loses its functional purpose. The founders of this theory believed that the

thymus gland reaches its maximum functional development in newborns. However, there are justifications for the morphofunctional significance of this gland in northern animals during all periods of individual development and age-related changes in the organ before the onset of biological death. In a 4-week-old embryo, the reticuloendothelial complex and its cellular elements are formed.

The thymus is the central organ of immune defense, which is subject to age-related changes, in addition, it is extremely sensitive to stress. It is known that chronic stress causes involution of the thymopoietic component of the gland, followed by structural reorganization of the organ and its atrophy, while changes in the gland are similar to age-related involution, but occur much faster [20]. Surgical stress also has a short-term but reversible negative effect on the thymus [11].

The thymus is a combination of epithelial and mesenchymal reticulum and together with the capillary network form the Reti - culo - endothelial complex. Epithelial cells differentiate and different generations of thymocytes appear . It has been proven that thymus T-lymphocytes regulate cellular immunity in the body and form thymus-dependent organs (spleen, lymph nodes, etc.). The epithelial islands of the thymus gland of young adult animals secrete into the blood a secret containing hormones of the thymosite family . These hormones regulate humoral immunity in animals and humans [9]. The development of T-lymphocytes is the result of the interaction of progenitor cells and immature thymocytes with components of the thymic stroma, which contains several types of cells that provide a supporting scaffold and form a microenvironment for the development of thymocytes [6].

It is known that medullary dendritic cells in the thymus and some populations of epithelial cells that enter the perivascular spaces of the medullary zone give a positive reaction with the marker of neuroectodermal differentiation S-100, and with synaptophysin - neuroendocrine cells of the brain zone, which are classified as cells of the DES series [6, 17].

As a result of immunohistochemical studies [7], the presence of serotonin was found in the precursors of T-lymphocytes (CD4-CD8 -), in immature cortical cells (CD4 + CD8), in mature medullary cells (CD4 + CD8 -). , as well as in epithelial cells that form Gass bodies . Autopsy studies of the thymus of people of different age groups made it possible to check the expression of serotonin in human thymus cells at all stages of ontogenesis. A significant increase in the number of cells containing serotonin in the elderly and the preservation of this hormone in senile and long-lived people at the same level as in the initial stages of ontogenesis were noted. The intensity of serotonin synthesis in ontogeny does not change. The data obtained convincingly indicate the preservation of the endocrine function of the gland during aging [13].

The regenerative potential of the thymus was studied in adults (54 people) who received chemotherapy for 12 months for lymphoma . The dynamics of thymus activity was analyzed by evaluating structural changes in the thymus using sequential computed tomography, correlating them with the results of the study of the thymus by simultaneous analysis of circles of excision of T-cell receptors (sjTREC) and CD3i (+), recently emigrated from thymus (recent thymic immigrants - RTE) in peripheral blood. In addition, regeneration processes in the thymus were assessed based on the recovery of peripheral CD4 (+) T cells after chemotherapy. An increase in the target organ after chemotherapy compared to baseline, called recurrent thymic hyperplasia, was found in 20 patients aged 18-53 years (mean 33 years). Using general linear models of mathematical analysis, it was found that in patients with hyperplasia, sjTREC and CD3i (+) RTE levels recovered faster after chemotherapy than in patients of the same age, gender, diagnosis, disease stage, and thymic function at baseline . level , but without hyperplasia. These data show that the thymus gland in adults retains the ability to regenerate after chemotherapy, especially in younger people. The presence of hyperplasia may contribute to the renewal of thymopoiesis and

replenishment of the pool of peripheral CD4 (+) T cells after chemotherapy in adults [15].

The main function of the thymus gland is to ensure the development of T-lymphocytes. The role of cytokines produced in the thymus is mainly to support the main processes carried out in the thymus, i.e. T- lymphopoiesis . Cytokines also coordinate intercellular relationships. It was found that the main role in the formation of T cells belongs to IL-7, produced by thymic epithelial cells. This process also involves products of the cell stroma (SCF-stem cell factor, cytokines of the IL-6 family, IL-15, pro- inflammatory cytokines) or thymocytes themselves (cytokines acting through y (C) -containing receptors - IL-4, IL-2 ,IL-9)[4,16].

The influence of various immunomodulators on the immune system has been studied. Polyoxidonium - derivative heteroceptive polyamines containing highly polar N -oxide groups leads to an increase in the number of CD 4- CD 8 + - thymocytes without changing their relationship to CD 4 + CD 8- cells [8].

In an experiment on white outbred male rats [13], which were intramuscularly injected with cyclophosphamide , imunofan , and their combinations, it was found that the course administration of imunofan leads to a change in the morphology of the thymus and the functioning of its bioamine-containing structures. . Imunofan significantly increases the width of the cortical layer, the diameter and area of the thymus medulla with a corresponding increase in organ weight 7 and 14 days after the end of the injection course. An increase in the number of luminescent granular cells in the cortico-medullary and subcapsular zones is detected after 1 and 14 days. After 14 days, the cells of both the cortico-medullary and subcapsular zones become larger and densely filled with granules. It was shown that the use of Imunofan against the background of the introduction of cyclophosphamide increases the mass of the thymus, the size of the cortical and medulla of the lobes and accelerates the restoration of thymus cytoarchitectonics . Recovery processes occur within 1 day after the combined course. After 7 days, the thymus mass and the size of the cortical and cerebral substance in rats with isolated administration of cyclophosphamide and in the group with combined administration of cyclophosphamide and imunofan differ little, but there is a tendency to normalize the structure of the thymus. After the combined administration of imunofan and cyclophosphamide , the structure of the thymus and the supply of cells with bioamine significantly differ from those with the isolated administration of both drugs. It was found that the increase in the size of the cortical and medullary lobules with the introduction of Imunofan occurs due to the activation of thymocyte proliferation and differentiation , which can be mediated by the inclusion of various factors that control the growth and development of lymphocytes.

Conclusion

Morphological studies of the central and peripheral organs of the immune system make it possible to assess age-related changes in the functioning of the immune system in response to factors of various nature. Modern immunohistochemical research methods create opportunities for elucidating stromal relationships in the organs under study. Further study of the morphological and functional organization of the organs of the immune system will make it possible to identify and analyze the patterns of structural and functional changes in the immune organs under the influence of factors of various origins on the body.

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