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MORPHOLOGICAL FEATURES OF THE FORMATION OF LYMPHOID TISSUE OF THE SPLEEN IN EARLY POSTNATAL ONTOGENESIS

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Abstract: This thesis presents the morphological features of the spleen structure at various stages of growth and development in the early postnatal period in healthy rats born to mothers with conditions related to pregnancy.

Keywords: spleen, white pulp, red pulp, lymphoid follicle, germinal centers, mantle zone, marginal zone, morphogenesis.

Objective. The purpose of the present study was to determine the morphological features of the development and formation of the spleen in rats during early postnatal ontogenesis in healthy animals born to mothers with a physiological course of pregnancy.

Materials and Methods. The experiments were carried out on 100 healthy rats born to mothers with a physiological course of pregnancy. Female rats were kept under standard laboratory conditions and on a standard diet. On the 31st day of the experiment, the females were placed with healthy males. Pregnancy was determined by the presence of spermatozoa in vaginal smears of the females.

Postnatal morphogenesis of the spleen was studied in the offspring of rats on the 1st, 3rd, 7th, 14th, 21st, and 30th days after birth.

For morphological examination, spleen tissues were fixed in a 10% neutral formalin solution or Bouin's fluid, then dehydrated in graded alcohols (60°, 70°, 80°, 96°, and 100°) and embedded in paraffin. Sections obtained with a microtome were deparaffinized in xylene and toluene and stained with hematoxylin and eosin for examination by morphological and morphometric methods. The study used the light microscopy method.

For morphological and morphometric analysis of the sections, an image analysis system was used, consisting of an OLYMPUS CKX53 (Japan) microscope with a digital camera and a personal computer equipped with cellSens software.

Results and Discussion. Our studies showed that the spleen of rats undergoes certain structural and functional rearrangements during postnatal growth, characterized by a sequential age-dependent dynamic.

In newborns during the first day after birth, the parenchyma of the spleen is mainly represented by the red pulp, which consists predominantly of connective tissue and erythroid cells, among which single megakaryocytes are visualized. A formed white pulp is absent.



Date: 3rd November-2025



On the third day of postnatal life, further development of the spleen parenchyma in rats is observed, which is manifested by an increase in the number of megakaryocytes and blast cells, along with erythroid cells. Around the muscular-type arteries, a small accumulation of lymphoid cells composed of small and medium lymphocytes is observed. This process can be regarded as the initial stage of white pulp formation in the spleen, since later, a thymus-dependent zone of the white pulp develops in these areas. The presence of light blast cells and megakaryocytes against the background of darkly stained erythroid cells gives the spleen tissue at this age a characteristic “mottled” appearance.

The 7th day of postnatal development can be considered a critical period, since at this time significant quantitative and qualitative rearrangements occur in both the parenchyma and the stroma of the spleen.

At this stage, the red and white pulps of the organ are clearly distinguishable. The red pulp mainly consists of reticular tissue, venous sinuses, megakaryocytes, and erythroid cells forming small clusters. The number of megakaryocytes and erythroid cells slightly decreases. The developing white pulp is represented by clusters of lymphocytes, single monocytes, and macrophages, in the center of which lies a central artery. Small and medium lymphocytes surrounding the artery form the thymus-dependent zone. Between the thymus-dependent zone and the red pulp lies the marginal zone, consisting mainly of small and medium lymphocytes. The marginal zone is separated from the red pulp by a marginal sinus, the wall of which is lined with flat endothelial cells. The germinal or light center is not yet detected at this stage of the study. In the marginal zone, in addition to lymphocytes, single macrophages are found, characterized by the presence of small lysosomes in the cytoplasm and irregularly shaped nuclei.

On the 14th day of postnatal development, further differentiation of the spleen parenchyma and formation of its stroma occur. During this period, the white pulp is clearly separated from the red pulp and represented by lymphoid nodules significantly increased in both number and size. During this time, the most pronounced changes occur in the arteries of the white pulp and trabeculae. They are characterized by a marked thickening of the muscular wall and widened lumina. The white pulp, as in the previous period, consists of two zones. The marginal zone becomes slightly expanded and denser. Germinal centers, as in the previous period, are not observed. At the same time, in this period, the number of lymphoblasts and prolymphocytes in the lymphoid follicles increases, among which cells undergoing mitotic division are found.

On the 21st day of postnatal ontogenesis, predominant development of the white pulp of the organ is observed. This is accompanied by an increase in the number and diameter of lymphoid nodules.

It should be noted that in individual lymphoid follicles, unlike in the earlier stages, indistinct germinal centers appear. At the same time, in each follicle, in addition to the periarterial and marginal zones, an intermediate zone can be distinguished, located between them. It mainly consists of medium lymphocytes, among which individual lymphoblasts, plasmoblasts, plasma cells, and macrophages are found.

Date: 3rd November-2025

The structure of the red pulp at this stage does not undergo significant changes. A noticeable decrease in the number of erythroblastic islands and megakaryocytes is observed, as well as the appearance of isolated diffusely distributed lymphoid cells among the formed blood elements.

By the 30th day, the capsule and trabecular apparatus become significantly thickened and contain well-defined connective tissue and smooth muscle cells.

The white pulp of the spleen is represented by periarterial lymphoid sheaths surrounding the pulp arteries and lymphoid nodules of rounded or elongated shape, surrounded by a ring of small lymphocytes (mantle zone), which borders the marginal zone formed by large lymphocytes and macrophages. The mantle and marginal zones of the lymphoid nodules are separated by a marginal sinus, clearly visible under light microscopy.

Unlike in the previous period, during this stage, the number of lymphoid follicles with germinal centers in the spleen increases. In their germinal centers, blast cells, macrophages, and reticular cells are mainly localized. The diameter of the lymphoid follicles, as well as the density of cell distribution within them, increases significantly compared to the earlier stages. Cells undergoing mitotic division are observed much more frequently in the germinal centers and relatively less often in other zones of the white pulp.

The periarterial zone is represented by accumulations of small and medium lymphocytes surrounding the eccentrically located central artery. Between the lymphocytes, individual reticular cells are found. The marginal zone represents the peripheral part of the lymphoid follicle, which tightly surrounds the germinal center and the periarterial zone. It mainly consists of clusters of medium and small lymphocytes, among which individual macrophages, reticular, and plasma cells are localized.

Conclusions

1. During early postnatal ontogenesis, the spleen undergoes significant structural remodeling involving both the stroma and parenchyma of the organ. In the first three days, processes of erythro- and thrombocytopoiesis predominate, while the lymphoid apparatus of the organ remains in a rudimentary state.

2. Starting from the 7th day, intensive development of the white pulp of the spleen occurs. This process is accompanied by gradual complication of the organ's vascular system, a decrease in the intensity of erythro- and thrombocytopoiesis, and an increase in lymphocytopoiesis and antibody formation in the spleen.

3. By the 21st day of postnatal development, the complete formation of the structural and functional zones of the spleen occurs, reflecting the morphological characteristics of the spleen in adult rats.

