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Comparative Morphological and Morphometric Parameters of Spleen in Normality and its Lymphoid Structures, Depending on Age in Experiment

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Abstract

The total number of lymphocytes in lymphatic nodes without a focus on reproduction was higher at 6-month-old age, and in the periarterial lymphatic sheath (PALS) at 6-month-old age, respectively, 56,3±0,95 and 61,2±0,75 cells. And at the age of 3 months, this indicator was the lowest value (46,6±1,12 and 48,3±1,2 cells, respectively).

Keywords: *Morphology, spleen, morphometric parameters, lymphoid nodules.*

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Introduction

The Relevance of the Problem. The protection of a living organism is impossible to imagine without the immune system. The immune system of humans and animals is one of the most active systems that quickly respond to the effects of various pathogens and participate in the adaptation processes of the body [1,6].

The organs of the immune system perform the function of adaptive immunity, which is the cellular and humoral immunity of the body. The most prominent and large peripheral organ is the spleen [2,3,12].

In recent years, the interest of morphologists in studying the structure of the spleen, associated with the rapid development of immunology, has increased in recent years [4,5].

According to researchers, the lymphoid structure of the spleen has a much more complex structure than other peripheral organs of the immune system [7,9].

The basis of the lymphoid structure of the spleen is the white pulp and its parts, namely, the periarterial lymphatic clutch and lymph nodes with reproduction centres, mantle, border and periarterial regions [8,10, 11].

The spleen is an organ of immunogenesis and lymphopoiesis, in which antigen-dependent differentiation of immunocompetent cells, the formation of effector cells and memory cells, as well as the elimination of obsolete and damaged hematopoietic cells occur [11,12].

It has a complex anatomical structure of immunocompetent white pulp, including periarterial lymphoid couplings, lymphoid nodules with germinal centres, peri-arterial, mantle and marginal zones. This structure creates favourable conditions for effective cooperative interaction of cells involved in the immune response [6].

The spleen has various and rather unexplored functions. The most important function of the spleen is the function of the immune system. It consists of neutralizing harmful substances with the help of macrophages and purifying the blood from iodine particles [Puschett, J. B., Agunanne, E., & Uddin, M. N. (2010)].

Currently, the world is experiencing an increase in diseases associated with damage to the immune system. According to researchers, the increase in the number of such diseases is associated with environmental pollution, which leads to a violation of the protective functions and adaptive processes of the body [Karmaus, W., & Johnson, C. C., 2005; Odacı F. et hand., 2010].

According to many researchers, various chemical and biological factors occur in the spleen, as well as stress, severe pathological conditions, hyperregulation, morphological changes [Klimenko N. A., 2007, Moroz G. A., 2011, Bakhmet A. A., 2014].

Despite many studies devoted to the study of the immune system of the human spleen and in experimental animals, almost no attention is paid to the issues of microanatomy and the cellular composition of the lymphoid structures of this organ [7].

Materials and Methods

The spleen of newborn white rats is located in the abdominal cavity, under the left costal arch, with a large curvature of the stomach. The colour of the organ is dark red, the consistency is soft. It borders on the diaphragm, the back wall of the stomach, the pancreas, the colon, the left kidney, the left adrenal gland (Fig.1).

Figure 1. Newborn White Rat Spleen Topography: 1-Spleen, 2-Stomach, 3-Small Intestine

In the spleen, there are 2 parts: facing the diaphragm (parietal) and stomach, concave – visceral surface. The two surfaces are separated from each other by a blunt bottom (facing back and down) and a sharp upper edge (facing forward and up). In addition, in the spleen, the posterior end is different - facing up and back, compared to the anterior (ventral) and spine – facing down and forward, relative to the left costal arch. The anterior end of the spleen is dilated, the posterior end is narrowed. The surface of the diaphragm of the spleen is smooth, and on the visceral surface, there are the gates of the organ. Through it, the blood vessels enter the organ. (Fig.2).

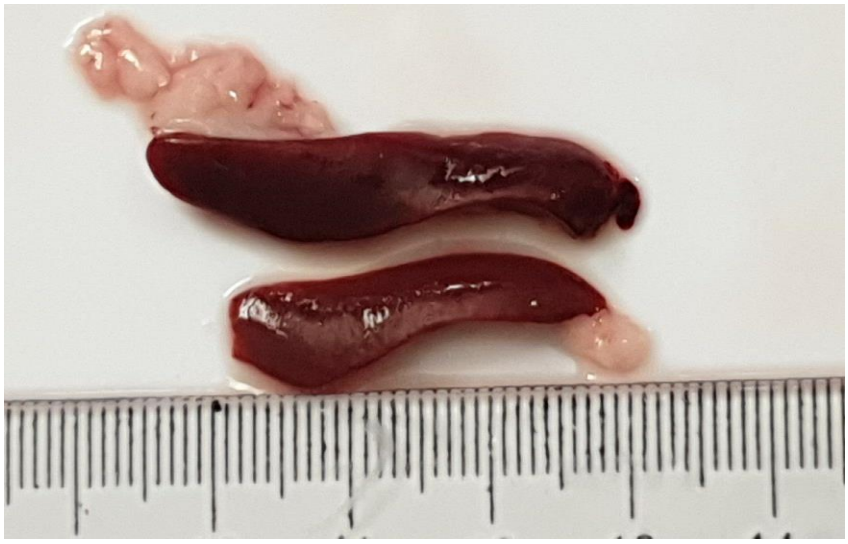

Figure 2. Newborn White Rat Spleen. 1 - The Front Edge of the Spleen, 2 - The Gate of the Spleen, 3 - The End of the Spleen (Previous), 4 - The Bottom of the Spleen (Back) End

Newborn white rats spleen from the outside is covered with a capsule made of thin connective tissue. From the capsule into the organ itself is a network of trabecules that protect the arteries and veins. In member parenchyma, the red and white pulp is distinguished. In histological incisions, the red pulp is made up of venous sinuses and fibrous tortures located between them. Newborn white rats white pulp consists of the periarterial lymphatic sheath (PALS) and lymphatic node (LN), which can not be distinguished. It is possible to identify the areas of the mantle and border in the primary lymphatic nodes with low numbers. In LN, the centres of reproduction (RC) are clearly visible.

The study found that the weight of newborn animals was from 4,5 g to 6,1 g, averaging 5,2±0,17 g, respectively. The absolute weight of the spleen is 0,03 - 0,05 g, on average equal to 0,037±0,017 g. The weight index was from 0,534% to 0,765%, on average 0,619±0,011%.

The length of the newborn white rat's spleen was from 5,6 mm to 8,5 mm, on average - 7,1±0,27 mm. The width of the spleen is 1,5-3,1 mm, on average – 2,42±0,15 mm. The width of the spleen was from 0,9 mm to 2,1 mm, on average -1,3±0,13 mm.

The relative area of the white pulp was from 13,9 to 19,7%, averaging 16,13±0,62%. The relative area of the connective tissue elements is 5,1% - 6,3%, on average – 5,83±0,14% (compared to the total area of the spleen incision).

PALM diameter ranged from 88,5 microns to 106,1 microns, averaging 97,4±2,15 microns. LN diameter is 215,1-248,3 μm, on average-245,56±3,52 μm. In one-third of the total number of lymphatic nodes, it is possible to identify the mantle and border areas.

The width of the mantle area was from 26,2 μm to 36,4 μm, on average 34,18±1,17 μm. The width of the border area is 53,8 μm - 67,9 μm, which is equal to an average of 63,42±1,36 μm. The width of the Periarterial sphere was from 39,1 μm to 47,6 μm, on average 45,13±1,14 μm.

Newborn white rats white pulp of the spleen consists of small, medium and large lymphocytes of different stages of maturation.

At the age of three months, the white rat spleen is fully formed. The following data were obtained when a healthy rats spleen was studied at the age of 3 months:

The bodyweight of animals at the age of 3 months was from 92 g to 127 g, on average 117,26±3,46 g. The absolute weight of the spleen is 0,4 - 0,8 g, on average – 0,61±0,035 g. The weight index was from 0,337% to 0,554%, on average 0,464±0,026%.In comparison with the newborn white ratsushs indicators, the animal weight increased by 21.03 times, while the member absolute weight increased by 15.85 times.

The length of the spleen was from 21,7 to 28,9 mm, on average - 26,38±0,57 mm. The growth rate is equal to -268,0%. The width of the spleen was 4,5-7,3 mm, on average – 5,85±0,24 mm. The growth rate is equal to -167,3%. The thickness of the spleen was from 1,9 mm to 4,1 mm, on average - 2,82±0,21 mm. The growth rate is equal to -139,5%.

The member parenchyma in healthy white rat histological preparations at the age of 3 months was clearly distinguished from each other by red and white pulp.

The relative area of the white pulp was from 19,7% to 25,5%, on average - 23,2±0,61%. Compared with newborn white cabbageushs, the relative area of white pulp increased by 28.7%. The relative area of the connective tissue elements was from 5,5% to 6,6%, on average – 5,92±0,2% (compared to the total area of the spleen incision).

On the white pulp of the spleen, it is possible to clearly distinguish periarterial lymphatic glands and lymphatic nodes. The diameter of the PALM was from 125,4 μm to 141,6 μm, averaging 133,17±1,63 μm. The growth rate is equal to 32,8%. The diameter of the lymphatic nodes increased by 95%, compared with the newborn ratushlar, and was from 356,7 microns to 478,03 microns, making up the average 467,04±12,34 microns. The per cent ratio of primary and secondary LN is equal to 36% and 71%, respectively. Centres of reproduction, formed in secondary LN, were determined. The diameter of the RC lari is from 97,2 microns to 165,3 microns, averaging 145,4±6,65 microns. LN is large and some are joined by each other. Lymph nodes of the spleen have a predominantly circular, oval and oblong shape.

In most cases, the functional areas in lt are clearly distinguished. The width of the mantle area was from 38,5 μm to 48,65 μm, and the middle was 44,62±0,79 μm. The width of the border area is 72,1 μm - 85,4 μm, on average equal to 76,24±1,35 μm. The width of the periarterial sphere was from 82,1 μm to 88,5 μm, on average 85,34±0,67 μm. The width of the mantle, border and periarterial areas increased by 27,65%, 23% and 91,5%, respectively, when compared with newborn rats.

The study found that the total number of lymphocytes in LN without a focus on reproduction was 41-54 units, on average - 48,2±1,13.

The total number of lymphocytes in periarterial lymphatic vessels was 41-54 units, on average - 48,1 ±1,6 cells,

White cabbage weight at the age of 6 months ranged from 180 g to 230 g, averaging 210,2±5,6 g. The absolute weight of the spleen is 0,7 - 1,1 g, on average– 0,81±0,035 g. The

weight index was from 0,316% to 0,408%, the mean was 0,338±0,05%. Compared to the 3-month-old age rats, the bodyweight of the animals increased by 1,84 times.

The length of the spleen was from 25,4 mm to 36,6 mm, on average - 32,65±1,2 mm. The growth rate is equal to 17,5 %. The width of the spleen was 8,7-7,5 mm, on average – 6,25±0,02 mm. The growth rate is equal to -6,74 %. The thickness of the spleen was from 2,3 mm to 4,5 mm, on average - 3,24±0,21 mm. The growth rate is equal to 6,79 %. The relative area of spleen white pulp in white rats aged 6 months in the control group was from 17,8 to 25,2%, averaging -21,34±0,71%. The relative area of the white pulp decreased by 8,2% when compared with the 3-month-old rat. The relative area of the connective tissue elements was from 5,7 % to 6,8%, on average – 6,34±0,17 % (compared to the total area of the spleen incision).

The palm diameter was 132,4 μm to 142,5 μm and averaged 137,12±1,52 μm. The growth rate is equal to-3,2 %. The diameter of the lymphatic nodes ranged from 376,5 to 481,03 μm, with an average of 431,92±10,23 μm. The present ratio of the primary and secondary LN is equal to 33% and 64 %, respectively. The diameter of the centres of reproduction was from 124,5 μm to 145,6 μm, on average 133,5±2,63 μm. The diameter of LN and RC was reduced by 10,4% and 9,32%, compared with rats at the age of 3 months. LN has a circular, oval and oblong shape.

The width of the mantle chamber of the spleen LN was from 38,6 μm to 51,6 μm and consisted of the middle 48,7±1,16 μm. The width of the border area is 73,5 - 84,1 μm, on average equal to 81,71±1,32 μm. The width of the periarterial area was from 82,7 μm to 93,6 μm, with an average of 87,35±1,16 μm. The width of the mantle, border and periarterial areas increased by 2,64%, 4,53%, and 5, 17%, respectively, when compared with the white rats at the age of 5 months.

The study found that the total number of lymphocytes in LN, which did not have a multiplication centre, was 53-63 units, on average - 57,2±0,97 units of cells. The total number of lymphocytes in LN, which do not have a focus on reproduction, increased by 4%, compared to 22,3-month-old white rats.

The total number of lymphocytes in periarterial lymphatic vessels was 52-63 units, on average - 59,3 ±0,76 units of cells. The total number of lymphocytes in Periarterial lymphatic vessels increased by 25,6%, compared with white rats aged 3 months.

Discussion and Conclusion

The analysis of the results of the study showed that the highest increase in the body and absolute weight of the member of newborn white rats was observed at 3-month-old age, respectively 23,04 and 17,15 times, respectively 6-month-old age, respectively 1,2 and 1,15 times increase.

The growth rate of the spleen length, width and thickness was the highest at 3-month-old age, respectively 268,0%, 181,4% and 145,2%, while at 6-month-old age was the lowest, respectively 6,78%, 0,71% and 0,82%.

The relative area of spleen white pulp in newborn white rats was 18,26±0,54%, increasing at a later age and decreasing after 6 months of age to the highest 23,1±0,62%, 6 months of age.

The relative area of the connective tissue elements was found to be 6,14±0,17 % in newborn white rats, this indicator was found to be relatively low (5,62±0,2%) in 3-month-old animals, while at 6-month-old age it was found to be more (6,51±0,12%).

The PALM diameter was 99,8±1,25 μm in newborn white rats and the highest value of this indicator was observed at the age of 6 months (134,70±0,83 μm).

The diameter of LN increased by 1,82 times at the age of 3 months and amounted to 457,03±12,17 μm. After 3 months of age, it gradually decreased, and at 6 months of age, it gained a value of 403, 8±6,59 μm.In the histological preparations of newborn rats, the centres of reproduction are clear, the maximum incidence of this indicator was observed at the age of 3 months (137,2±6,51 μm), the minimum was observed at the age of 6 months (123,2±2,24 μm).

The highest incidence of mantle, borderline, periarterial areas was observed at the age of 6 months with a decrease of 45,64±1,16 microns, 81,62±1,06 microns, 87,32±1,16 microns, respectively, after 6 months of age.

The total number of lymphocytes in LN without a focus on reproduction was higher at 6-month-old age, and in PALM at 6-month-old age, respectively, 56,3±0,95 and 61,2±0,75 cells. And at the age of 3 months, this indicator was the lowest value (46,6±1,12 and 48,3±1,2 cells, respectively).

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