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Morphological Characteristics of The Target Organs of Lymphoid and Digestive Systems Under Secondary Immunodeficiency Condition in Calves.

Tatiana N. Derezina^{2*}, Alexei A. Volkov^{1, 3}, Tatiana M. Ushakova², Sergey A. Staroverov^{1, 3}, Sergey V. Kozlov^{1, 3}, I.I. Kalyuzhnyi³, I.Yu. Domnitsky³, and Ivan A. Nikulin⁴.

¹ Federal State Budgetary Scientific Institution Saratov Scientific and Research Veterinary Institute, Saratov , Russia 6, the 53th Strelkovoi Divisii street, 410028

² The Don State Agrarian University, Russia, Rostov region, October district, v. Persianovskiy 1, Krivoshlykov 346493

³ Saratov State Agrarian University, Saratov, Russian Federation, 1, Teatralnaya squre 410012

⁴ Federal State Budgetary Educational Istitution of Higher Professional Education Voronezh State Agrarian University, Voronezh, 1, Michurina street, 394087

ABSTRACT

The article discusses the issues of patomorphology of target organs under secondary immunodeficiency condition in calves. The results of morphological studies of central and peripheral organs of the lymphoid system and duodenum at this pathology indicate profound morphological changes and confirm the complex combined nature of the calves' secondary immunodeficiency condition course.

Keywords: pathology, thymus, red bone marrow, spleen, lymph nodes, duodenum, calves, secondary immunodeficiency.

**Corresponding author*

INTRODUCTION

Intensification of livestock and high prevalence of infectious and non-infectious diseases result in the development of various pathological processes based on changes of homeostasis regulated by immune system. This causes the development of dysfunctional processes resulting in primary and secondary immunosuppressive conditions [1]. Furthermore, these changes may be compounded in the pathological process dynamics caused by various etiological factors [2, 3].

In recent years, the immune system pathology in young farm animals has been recorded quite frequently. This problem is urgent and it is presented in many works of modern scholars. As a rule, calves' immunodeficiency is caused by spending passively transferred maternal protection factors, the immaturity of the immune system, violation of local protection of the digestive tract at a sharp transition to a new diet and exposure to aggressive environmental factors [4, 5].

Under various pathogenic effects the young cattle in postnatal ontogenesis has complex changes leading to the development of environmentally caused secondary immunodeficiency in animal organisms [6, 7]. Secondary immunodeficiency in terms of pathogenesis has a complex mechanism of development and substantially influences the pathogenesis and sanogenesis of diseases. Secondary immune deficiency is characterized by changes in natural resistance and immunobiological reactivity, accidental transformation and atrophy of the lymphoid system and other body system disorders [8, 9]. The main trends in modern immunopathology of farm animals are the study of etiological aspects [10, 11] and the development of a proved and environmentally safe pharma-correction [12, 13, 14, 15], while pathomorphologic studies are not always given proper attention. Since immunopathology is typically complex that makes it difficult to distinguish the leading pathogenic link, and as far as it underlies the formation of numerous pathological processes involving deep frustration of the system level, the problem of complex studying the target-organ pathomorphology at the pathology of the immune system stays open [16, 17].

Therefore, only a more detailed and comprehensive study of the pathological characteristics of the central and peripheral organs of the lymphoid system and lymphoid lesions of calves with secondary immunodeficiency condition will reveal the etiopathogenesis issues and enable the veterinary professionals to implement more effective therapeutic and preventive measures. The research was aimed at the identification of pathogenic aspects of the calves' secondary immunodeficiency. The object of research was to study the morphological and functional state of the central and peripheral organs of the lymphoid system and duodenal ulcers of calves in secondary immunodeficiency condition.

MATERIALS AND METHODS

The studies have been carried out on the basis of the Don State Agrarian University and the All-Russian Research Institute of Veterinary Pathology, Pharmacology and Therapeutics of the RAAS. Scientific and industrial experiments, testing and production tests were carried out at the cattle farms of Veselovsky district in Rostov region.

To undertake research, 20 calves of two months' age with established secondary immunodeficiency were selected, with 5 ones being subjected to slaughter afterwards. Samples of lymph nodes (submandibular, mesenteric), thymus, spleen and duodenum were fixed in a 10-12% solution of neutral formalin and Carnoy's fluid, and were embedded in paraffin according to the standard technique. The sections were stained with hematoxylin and eosin, according to Van Gison method. The material fixing for electronic microscopy was performed in 2.5% glutaraldehyde on the 0.114 M collidine buffer in the cold with post fixation in the 1% solution of osmium tetroxide in the same buffer. The material was embedded in Epon-812. Semi-thin sections were prepared, which were stained with azure-2 in combination with basic fuchsin and were examined by the light microscope "Leica". Morphometric studies were performed according to by J.E. Hesin (1967) as presented by S.M. Suleimanov et al. [18].

RESULTS

The output of the morphological studies of the target organs at the pathology of the calves' immune system has revealed a diffuse hypoplasia of the lymphoid tissue of the lymph node cortical layer of the (Fig.

1a). Clear separation of the lymphoid tissue on the border of cortical and medullary layers was not observed, with the cortical substance containing a small amount of lymph follicles with poorly developed germinal centers. The boundary, intermediate and cerebral sinuses were swollen, serous fluid with single degenerative cell infiltrates was found. In the intermediate sinuses there were degranulation of granulocytes and dystrophic changes of reticular cells recorded (Fig. 1b). There was a significant "dilution" of the lymphoid tissue due to the reduced number of cellular elements. In this case, the density of cortical cells lymph node was $18,043 \pm 275 \text{ n/mm}^2$, and that of the brain - $15,798 \pm 319 \text{ n/mm}^2$.

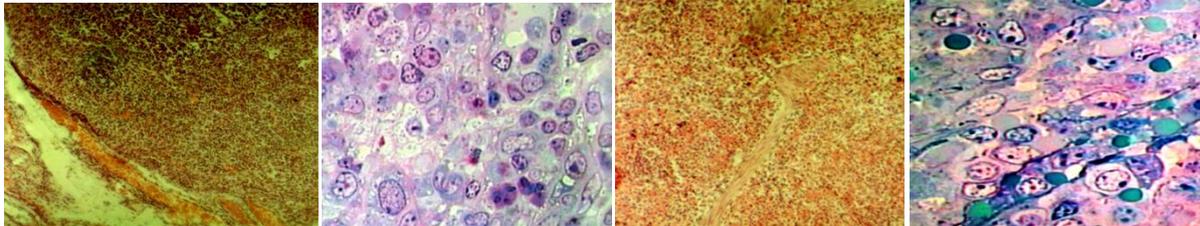


Figure 1. Structural organization of peripheral organs of lymphoid system of calves with secondary immunodeficiency conditions: a) - lymphoid tissue hypoplasia of a lymph node, hematoxylin and eosin colouring, increase by 7x10; b) - quantitative growth of dystrophic and degranulated granulocytes and reticular cells of the lymph node, azure-2 coloring combined with basic fuchsin, increase by 10x100; c) - the diffuse bands in the spleen white pulp of the, hematoxylin and eosin colouring, increase by 7x10; d) - isolated lymphoid and reticular cells in the parenchyma of the white pulp in the spleen parenchymal, azure-2 coloring combined with basic fuchsine, increase by 10x100.

In the spleen there was a marked hypoplasia of the white pulp lymphoid tissue recorded, diffusely infiltrating the red pulp (Fig. 1c) in the form of single lymphoid and reticular cells (Fig. 1d). The density of cells in the white pulp was $11,027 \pm 885 \text{ n/mm}^2$.

In the bone marrow an islet formation of hematopoietic cells was observed. Wherein, an accumulation of erythroblasts was seen around the iron containing macrophage. Foci of hematopoiesis consisted mainly of erythroblasts, erythrocytes, and single megakaryocytes filling the peripheral part of the reticular network. The amount of granulocytes was 2-3 times higher than the number of erythrocytes (Fig. 2a), due to their deposition in the red marrow. Megakaryocytes mostly were located near sinusoid capillaries, with a portion of their cytoplasm penetrating the lumen of the blood vessel, and the separated fragments of cytoplasm transferring into the bloodstream in the form of platelets. A significant amount of immature granulocytes and lymphoid cells surrounded the blood vessels (Fig. 2b), indicating the changes in the functional state of the marrow or a damage of its barrier. A significant decrease in the amount of stem cells lagging in the differentiation and development was also observed. This fact turned out to be a leading pathogenetic factor in the development of calves' secondary immunodeficiency.

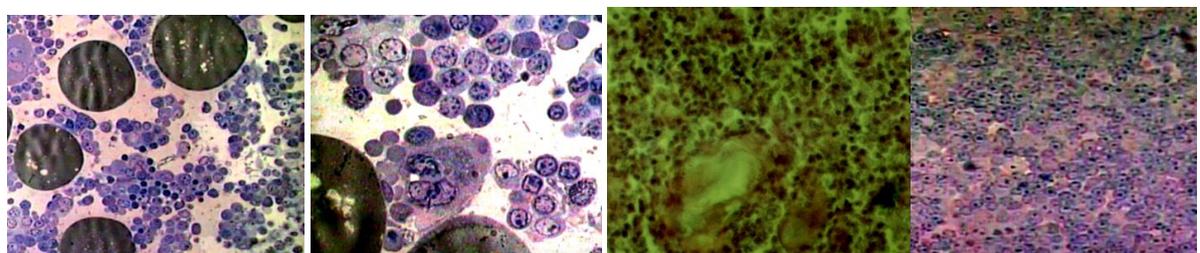


Figure 2: The structural organization of the lymphoid system central organs of calves under the secondary immunodeficiency condition: a) - foci of hematopoiesis in the red marrow; b) - the delay of myeloid hematopoiesis cell differentiation in the red marrow, with azure-2 coloring combined with basic fuchsine, the increase by 10x100; c) - dystrophy of Hassall corpuscles in the medulla of the thymus, hematoxylin and eosin colouring, the increase by 7x40; d) - hypoplasia of thymocytes and absence of

developed Hassall corpuscles in the thymus structure, the azure-2 colouring combined with basic fuchsin, the increase by 10x20.

In the thymus no clear distinction between cortical and medullary layers with brain zone expansion zone was observed.

Hypoplasia of the lymphoid tissue of the thymus was accompanied by lymphoid cells sparseness. In the medulla there were large Hassall corpuscles in dystrophy condition and formation delays (Fig. 2 c, d) the cortical cell density was $16,758 \pm 721$ n/mm², and that for brain – $15,155 \pm 651$ n/mm². On the duodenal mucosa the signs of inflammation of catarrhal-desquamative character were registered. The manifested morphological changes were accompanied by a sharp decrease of villus height and growth of crypt depth thickening. The cup shape cells showed an increase in volume and quantity and contained a lot of well-painted secretion (Fig. 3a). Focal swelling of enterocytes was registered at the villi base (Fig. 3b). At the same time the proliferation of lymphoid cells in the stratum of the intestinal mucosa and in the villi lamina was registered.

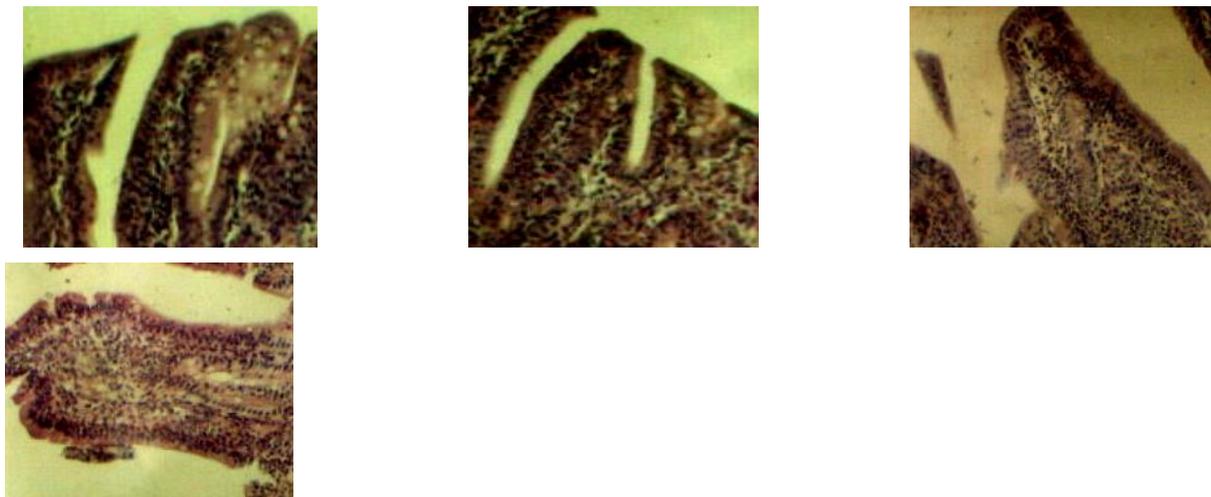


Figure 3. Structural organization of the duodenal mucosa of calves with secondary immunodeficiency condition: a) - increase in the number of cup shape cells; b) - focal swelling of enterocytes; c) - a violation of the villi architectonics; d) - the proliferation of lymphoid cells in the villi lamina, hematoxylin and eosin colouring, the increase by 7x10.

In some parts of the duodenum a violation of the architectonic was observed (Fig. 3c), the number of sudanophilic inclusions increased. In enterocytes an uneven distribution of acidic and neutral mucopolysaccharide compounds was registered. Simultaneously the lymphoid cell proliferation was observed in the mucous membrane of the intestine and in the villi lamina (Fig. 3a).

DISCUSSION

In the course of the research work, pathomorphological changes in the central and peripheral organs of lymphatic system and duodenum at the secondary immune suppression in calves were examined and thoroughly described. These changes point out to serious morphofunctional changes and multifactorial character of the pathology.

The research results greatly improve our knowledge of immune suppression in calves as the available literature mainly restricts to the information on the changes in general clinical indicators as well as hematological and biochemical changes at this pathology. For instance, Fedorov Yu. N. (2013) specifies that as a rule secondary immunodeficiency in calves is clinically accompanied with the diarrhea syndrome caused by pathogenic enterobacteria, rota- and coronaviruses. According to Suleimanov S.M., Shaposhnikov I.T. and Shaposhnikov Yu.V. (2011), immunodeficiency in calves results in hypotrophy, hypothermia, anemia, hemoglobinemia, and there is a decrease of total protein, albumen and gamma globulin in the blood serum. Topuria G.M. and Topuria L.Yu. [11] describe the decrease of neutrophil phagocytic activity as well as the

decrease of bactericidal activity of T and B lymphocytes and the drop in the amount of circulating immune complexes.

Pathomorphological changes in the central and peripheral organs of lymphatic system and duodenum were first thoroughly described based on the results of this research. Morphological changes are characterized by hypoplasia of the lymphoid tissue in the lymph nodes, spleen, thymus and bone marrow. Particularly, diffuse hypoplasia of the cortical lymphoid tissue was observed. The diffuse was accompanied by the absence of the clear border between the cortical and medullary lymphoid tissues, by the edema of marginal (subcapsular), intermediate (cortical) and medullar sinuses, and by the "rarefaction" of the lymphoid tissue due to the decrease of the cell elements. The changes in the spleen were marked by the severe hypoplasia of the white pulp lymphoid tissue. An islet formation of hematopoietic cells and the differentiation delay of the myelogenous hematopoietic cells in the red bone marrow were observed in the bone marrow; hematopoiesis centers predominantly consisted of erythroblasts, erythrocytes and single megakaryocytes which filled the peripheral part of the reticular network. As far as the thymus is concerned, the Hassall's corpuscles dystrophy was observed in the thymus medulla; hypoplasia of thymocytes and absence of well-developed Hassall's corpuscles in the thymus structure were detected. The increase of goblet cells, proliferation of lymphoid cells and the villi damage were discerned on the duodenal mucosa.

Thus, the results of morphological studies of the target organs of calves' lymphoid and digestive systems under secondary immunodeficiency condition, have revealed an interrelation between destructive changes in organs of lymphoid and digestive systems. Anyway, it is difficult to define the primary etiopathogenetical aspect of this pathology. It is obviously seen that morphological changes in the early postnatal period of development may violate the transfer of colostral immunoglobulins, thereby triggering the development of secondary immunodeficiency. Immunosuppression at the secondary immunodeficiency condition causes a decrease in the level of non-specific and specific resistance making calves organisms susceptible to various infectious and parasitic diseases, thereby exacerbating the course of pathologies.

Outputs. The secondary immunodeficiency in calves is presented by hypoplasia of central and peripheral organs of the lymphoid system. With the pathology of the immune system deep destructive changes are registered in duodenum. The may not only be the leading etiopathogenetical link of this disease, but can exacerbate further development of immunodeficiency.

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