CHANGES IN THE MORPHOLOGICAL STRUCTURE OF THE SPLEEN IN RATS IN EXPERIMENTAL MODERATE SPINAL CORD INJURY

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Relevance: It is well known that the spleen is the largest lymphoid organ in humans and other mammals and plays an important role in the formation and maintenance of cellular and humoral immune responses, ensuring the functioning of innate and adaptive immunity, as well as regulating the quantitative and qualitative composition of immunocompetent cells in the blood, lymph, and other lymphoid organs. In spinal cord injury, interruption of descending excitatory impulses leads to reflex depression below the level of the lesion, which clinically manifests as neurogenic shock and is accompanied by dysfunction of vital body systems.

Aim of the study: To determine morphological changes in the spleen of 3-month-old outbred white rats after a moderate spinal cord contusion.

Materials and Methods: A total of 148 outbred white rats of both sexes were used in the study. The animals were kept under standard vivarium conditions for three months. The rats were euthanized under ether anesthesia at the age of 7, 14, and 21 days of postnatal development. The following parameters were measured: the total cross-sectional area of the organ, the relative area of the white and red pulp, the area of lymphoid follicles, the diameter and number of periarterial lymphoid sheaths (PALS), as well as the density of cellular elements of the lymphoid tissue.

Results and Discussion: The study of the dynamics of morphological and morphometric changes in the spleen after a moderate spinal cord contusion makes it possible to identify patterns in the response of this immune organ to systemic stress.

On day 7 after moderate spinal cord contusion, moderate congestion of the red pulp with dilation of the venous sinuses is observed; in some areas they appear gaping, indicating impaired venous outflow and the development of stasis. Hemolysis in the perisinusoidal zones is focally expressed. At this stage, the white pulp already demonstrates a noticeable decrease in volume, and its architectonics becomes less distinct.

The periarterial lymphoid sheaths (PALS) are thinned, and their lymphocytic composition is depleted, indicating early loss of mature T-lymphocytes. Digital analysis clearly shows that T-lymphocytes (marked in red) decreased to 163 cells, which is one-third lower than the control values. B-lymphocytes (blue) accounted for 118 cells, with an even more pronounced decrease of 40%. At the same time, the number of blast elements (yellow) increased to 54 cells, representing 19% of the pulp. The white pulp occupied only 36.7% of the field area (1.03×10^6 px^2), whereas the red pulp expanded to 63.3% (1.78×10^6 px^2).

Morphometry confirms these observations: the area of the white pulp decreased to 0.84×10^6 px^2 (30.4%), while the red pulp occupied 69.6% of the field of view (1.92×10^6 px^2). The number of T-lymphocytes decreased to 104 cells, which is 57% lower than the control, and B-

lymphocytes to 73 cells (–63%). Meanwhile, blast lymphocytes maintained a relative increase—49 cells (22% of the cell pool).

If on day 7 some residual structural organization of the white pulp could still be observed, by day 14 a stage of pronounced atrophy with a critical reduction of the mature lymphocytic component becomes evident. At this time point, the red pulp shows signs of chronic hyperemia and increasing stromal changes, indicating the onset of organ remodeling.

In the third week (day 21) after moderate spinal cord contusion, the changes reach their maximum severity. The white pulp is represented by isolated, scattered follicles, and the germinal centers are uneven: in some they are preserved, while in others they are reduced to thin accumulations of lymphoblasts. The PALS zones are almost devoid of mature T-lymphocytes, and their architectonics are severely disrupted. The mantle zone disappears, and the marginal zone is extremely poorly expressed. The red pulp appears diffusely expanded and congested, with stasis and multiple foci of hemolysis observed within it.

Thus, analysis of the dynamics of the influence of moderate spinal cord injury on the spleen revealed pronounced progressive morphometric changes in the spleen of 3-month-old rats. These changes are characterized by a decrease in the area of the white pulp and a reduction in the number of T- and B-lymphocytes against the background of an increased proportion of blast cells, as well as expansion of the red pulp and enhanced collagenization of its stroma. The maximum severity of morphological changes was observed on day 21 after injury, reflecting the development of lymphoid tissue atrophy and the progression of fibrotic changes in the spleen.

Conclusions: The obtained data confirm that moderate spinal cord injury causes progressive suppression of the immune and structural function of the spleen. The greatest degree of damage observed by day 21 indicates a profound destabilization of the morphofunctional state of the organ.