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COMPARATIVE CHANGES IN MICROANATOMICAL ORGANIZATION OF LYMPH NODES DRAINING AND LOCATED IN A ZONE OF VENOUS STASIS

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Vascular pathology occupies a leading position in the morbidity structure of the population of developed countries; in the last decade there has been a rapid increase in the incidence of diseases accompanied by disturbance of the drainage function of the veins [2, 4, 7]. Meanwhile, the important role of the lymphatic system in the compensation of circulatory disorders arising in the presence of venous stasis has been proved quite conclusively during these years [2, 4-6], and a role of particular importance in these processes is played by the lymph node, as an instrument for the redistribution of fluid and cells between the blood vascular and lymphatic systems [2, 9, 10].

The state of lymph nodes located in a zone of venous stasis has been investigated in fair detail [2, 4, 6]. However, there have been no investigations of the structural and functional organization of lymph nodes draining a zone of venous stasis, but not located in it. The aim of this investigation was accordingly to compare the fine structure of lymph nodes lying in a zone of venous stasis and involved in the drainage of lymph from it, and also of lymph nodes located outside the zone, but receiving lymph from the region of stasis.

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TABLE 1. Microanatomical Organization of Popliteal Lymph Nodes of Rats at Various Times after Ligation of Caudal Vena Cava ($X \pm S_x$)

Feature studied	Control	Time after ligation of caudal vena cava, days			
		1	7	14	30
Section through lymph node	(A) 2,67±0,37	3,32±0,27	2,91±0,28	3,0±0,25	3,14±0,35
Capsule	(A) 0,083±0,008	0,124±0,012*	0,097±0,009	0,163±0,017*	0,214±0,019*
Marginal sinus	(A) 0,099±0,011	0,147±0,012*	0,104±0,008	0,085±0,009	0,072±0,005*
Cortical plateau	(A) 1,074±0,112	0,937±0,084	0,726±0,064*	0,675±0,054*	0,897±0,086
Medullary cords	(A) 0,408±0,039	0,472±0,046	0,457±0,039	0,527±0,042*	0,604±0,057*
Medullary sinuses	(A) 0,559±0,055	0,976±0,084*	0,807±0,074*	0,727±0,063*	0,592±0,050
Paracortical zone	(A) 0,293±0,037	0,274±0,031	0,327±0,034	0,353±0,038	0,316±0,027
Lymphoid nodules without germinal centers	(A) 0,090±0,009	0,084±0,008	0,097±0,009	0,097±0,008	0,124±0,011*
	(N) 4,6±0,5	7,3±0,7*	7,5±0,7*	5,4±0,5	4,0±0,4
Lymphoid nodes with germinal centers	(A) 0,154±0,015	0,304±0,027*	0,298±0,027*	0,314±0,032*	0,316±0,028*
	(N) 2,8±0,4	4,9±0,4*	5,2±0,5*	6,4±0,5*	3,7±0,4
Germinal centers	(A) 0,016±0,002	0,057±0,005*	0,127±0,012*	0,147±0,013*	0,207±0,021*

Legend. *A*) Area of cross section of structures, mm^2; *N*) number of structures per lymph node section. Asterisks indicate values differing significantly from control ($p < 0.05$).

TABLE 2. Microanatomical Organization of Renal Lymph Nodes of Rats at Different Times after Ligation of Renal Vein ($X \pm S_x$)

Feature studied	Control	Time after ligation of renal vein, days			
		1	7	14	30
Section through lymph node	(A) 2,718±0,245	3,847±0,375*	4,267±0,411*	4,266±0,372*	3,344±0,288
Capsule	(A) 0,088±0,007	0,090±0,007	0,112±0,006*	0,143±0,010*	0,201±0,018*
Marginal sinus	(A) 0,097±0,011	0,099±0,004	0,210±0,009*	0,174±0,013*	0,092±0,010
Cortical plateau	(A) 1,041±0,096	1,338±0,135	1,318±0,142	1,016±0,099	0,633±0,077*
Medullary cords	(A) 0,402±0,040	0,403±0,043	0,403±0,038	0,344±0,030	0,558±0,052*
Medullary sinuses	(A) 0,491±0,051	1,294±0,0117*	1,114±0,102*	1,010±0,104*	0,929±0,088*
Paracortical zone	(A) 0,300±0,031	0,294±0,029	0,299±0,031	0,400±0,039*	0,402±0,037*
Lymphoid nodules without germinal centers	(A) 0,102±0,010	0,123±0,013	0,198±0,021*	0,101±0,009	0,102±0,011
	(N) 6,003±0,398	3,532±0,298*	4,482±0,392*	2,011±0,192*	2,028±0,111*
Lymphoid nodes with germinal centes	(A) 0,197±0,017	0,206±0,017	0,613±0,029*	1,038±0,060*	0,427±0,042*
	(N) 3,045±0,294	2,522±0,233	5,839±0,537*	5,176±0,412*	2,216±0,191*
Germinal centers	(A) 0,019±0,002	0,070±0,003*	0,404±0,047*	0,432±0,043*	0,331±0,030*

Legend. *A*) Area of cross section of structures, mm^2; *N*) number of structures per lymph node section. Asterisks indicate values differing significantly from control ($p < 0.05$).

EXPERIMENTAL METHOD

Experiments were carried out on 100 mature male Wistar rats weighing 200-220 g. In the first series of experiments (50 animals, 10 at each time) the caudal vena cava was ligated under ether anesthesia at a point proximally to where the renal veins join it. Both popliteal lymph nodes, which after this operation were located in a zone of venous stasis, were removed for histological investigation. In the second series of experiments (50 animals, 10 at each time) the left renal vein was ligated under ether anesthesia at a point before where it is joined by the left adrenal vein, and regional lymph nodes for the kidney, the drainage of venous blood from which was obstructed, were removed for further investigation. The material was fixed in Bouin's fluid dehydrated in a series of alcohols, and embedded in paraffin wax. Sections 5-6 μ thick were stained with Mayer's hematoxylin and eosin and with azure II-eosin. The morphometric investigations followed the recommendations in [1].

EXPERIMENTAL RESULTS

The total area of sections of the popliteal lymph nodes cut through their long axis and lying in the zone of venous stasis did not change significantly whereas lymph nodes draining the region of stasis, but not located in it, were sharply increased in volume (Tables 1 and 2).

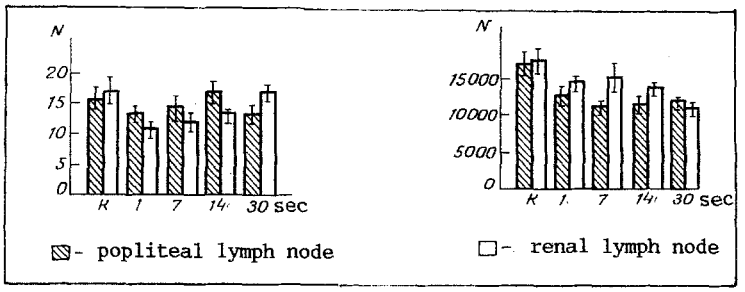

Fig. 1 Fig. 2

Fig. 1. Dynamics of change in numerical density of cells, calculated per 1000 μ^2 area of cross section of the cortical plateau of lymph nodes at different times of experimental venous stasis.

Fig. 2. Dynamics of change in number of cells calculated per area of cross section of zone in cortical plateau of lymph nodes at different times of experimental venous stasis.

The increase in area of cross section of the capsule of the popliteal lymph nodes 1 day after ligation of the caudal vena cava was due to edema and loosening of the fibers, but these phenomena are not characteristic of the renal lymph nodes. Meanwhile sclerosis of the lymph nodes, manifested as an increase in the area of cross section of the capsule and coarsening of its fibers, could be seen in the renal lymph nodes as early as on the 7th day of venous stasis, but in the popliteal lymph nodes not until the 14th day (Tables 1 and 2).

Lymph nodes located in the zone of venous stasis were characterized by a transient and small increase in volume of the marginal sinus, due largely to retrograde movement of fluid from the medullary sinuses into the cortical, and subsequently into the marginal sinus [2, 4, 11]. In the late stages of the experiment the volume of the marginal sinus actually decreased, possibly due to a decrease in volume of afferent lymph flowing into the lymph node [8]. The lymph node draining the region of stasis but not located in it was characterized by a sharp increase (more than twofold) in the area of cross section of the marginal sinus during long periods of the experiment, due to an increase in the volume of afferent lymph flowing into the node [2, 6].

The area of cross section of the cortical plateau of the popliteal lymph node during venous stasis fell progressively, and not until the later stages of the experiment did it show a tendency to increase. The dynamics of the change in this parameter of the renal lymph node was opposite in character (Tables 1 and 2). A more detailed study of this zone of the lymphoid parenchyma showed that the renal lymph node was characterized by marked edema of the cortical plateau, as shown by a sharp decrease in the numerical density of cells located in it (Fig. 1). It is remarkable that whereas 1 and 7 days after ligation of the renal vein a tendency was found for the volume of the cortical plateau to increase, the total number of cells in that region decreased significantly (Fig. 2). A decrease in the total number of cells in the cortical plateau of the popliteal lymph node was observed even when their numerical density was increased (after 14 days).

Venous stasis leads to hyperplasia of the medullary cords, which was more marked in the popliteal than in the renal lymph nodes. The volume of the medullary sinuses increased more in the renal lymph nodes. This process leads to a sharp fall in the value of the MC/MS ratio for the medullary substance of the renal lymph node (Fig. 3). In the popliteal lymph node this index after 30 days of venous stasis was significantly higher than in the control. This fact is evidence of stronger stimulation of the B zone of the medulla in lymph nodes lying in the zone of venous stasis [2, 4, 8, 11]. Nevertheless, marked hyperplasia of the paracortical, T-dependent zone was observed in lymph nodes draining the zone of stasis but not located in it (Tables 1 and 2).

In both experiments venous stasis was a powerful stimulator of growth of the lymphoid nodules and the formation of germinal centers in them. Here also, however, marked differences were observed, for in the popliteal lymph nodes the increase in mass of the lymphoid tissue located in lymphoid nodules took place on account of an increase in the number of these structures, whereas in the renal lymph nodes it resulted from an increase in their volume. The relative number of lymphoid nodules with germinal centers in the structure of the whole population of these formations showed a more significant increase in the renal lymph nodes (Fig. 4).

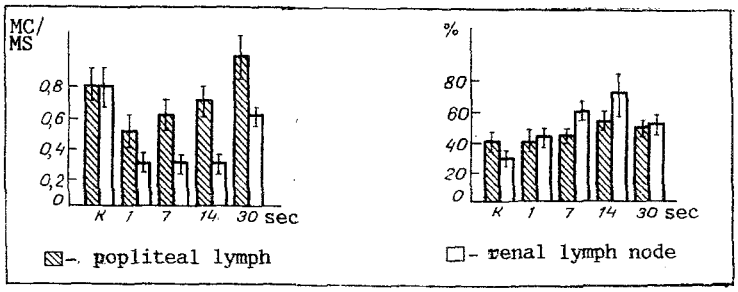

Fig. 3 Fig. 4

Fig. 3. Dynamics of change in MC/MS ratio (ratio between areas of cross section of medullary cords and medullary sinuses in sections of lymph nodes) at different times of experimental venous stasis.

Fig. 4. Dynamics of change in relative number of lymphoid nodules per section of lymph node at different times of experimental venous stasis.

The different location of a lymph node draining the zone of venous stasis (located inside or outside the zone of venous hypertension) thus leads to qualitatively different types of reorganization of the structure and function of lymph nodes. This reorganization is aimed at compensating circulatory disorders arising when the drainage function of the veins is disturbed and it is accompanied by marked and irreversible changes in the lymph nodes.

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