Effect of Dehydration on Morphogenesis of the Lymphatic Network and Immune Structures in the Small Intestine

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Dehydration was accompanied by cell changes in solitary lymphoid nodules and Peyer's patches. The proportion between lymphocytes, macrophages, and mast cells in lymphoid organs depended on the stage of dehydration. The inhibition of cell mitoses, disappearance of mature plasma cells and mast cells (per field of view), significant decrease in lymphocyte count, 4-5-fold increase in the number of destructive cells, and low density of cells and lymphatic network of the small intestine (per unit area) were observed on days 6 and 10 of dehydration. Severe morphological changes were also revealed in other layers of the small intestinal wall (mucosa, submucosa, lamina propria, *etc*.).

Key Words: *small intestine; solitary and aggregated lymphoid nodules; dehydration; lymphatic network; albino rats*

Studying the interstitial fluid transport into lymphatic roots under the influence of natural and preformed therapeutic agents is important for the therapy of patients with lymphatic disorders (edema, dehydration and intoxication). It is necessary to develop new theoretical and morphological bases for evaluation of the effect of hydrologic factors on arterial, venous, lymphatic, nervous, immune, endocrine, urogenital, respiratory, and musculoskeletal system [5,6,9].

Here we studied the effect of dehydration (3, 6, and 10 days) on lymphoid structures and lymphatic network in rat small intestine.

MATERIALS AND METHODS

Experiments were performed on male albino rats weighing 180-200 g. Control animals (intact specimens, n=10) had free access to water. Treated rats received only dry oats (waterless diet) for 3, 6, and 10 days (dehydration, 10 specimens for each period). The rats were housed in individual cages and after the experiment were decapitated under thiopental anesthesia.

We examined the middle segments of the duodenum and jejunum, as well as the terminal segments of the ileum. The samples were stained with hematoxylin and eosin, azure-nitrofungin-fuchsin, Romanovsky—Giemsa stain, Van Gieson and Kurnik stain, silver nitrate (Foot technique), and Mallory stain (for collagen fibers). The cell composition of lymphoid structures in the small intestine (lymph nodules with no germinal center; mantle; germinal centers; and internodular area) was evaluated per unit area of the histological section (900 μ^2) using a morphometric grid of A. A. Glagolev with modifications of S. B. Stefanov. Microtopographic and morphometric parameters were studied under a MBR-1 microscope (ocular magnification ×10; objective magnification ×8, ×40, and ×90).

RESULTS

The structure of cells in lymphoid nodules, intestinal and gastric glands, and layers of the small

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TABLE 1. Morphometric Parameters of the Lymphatic Network in the Small Intestine on Day 3 of Dehydration (mm, $X \pm Sx$)

Parameter	Mucosa		Submucosa		Muscle layer		Serosa	
	control	treatment	control	treatment	control	treatment	control	treatment
Lymphatic capillaries	85.0±3.4	75.0±2.4	125.0±5.6	104.2±1.8	45.2±1.5	35.5±0.5	35.4±0.4	30.5±1.2
Lymphatic lacunas	120.5±5.6	106.0±3.6	250.0±7.8	210.4±5.8	90.5±1.3	80.0±4.2	110.0±4.2	75.4±3.5
Density of lymphatic network loops per 1 cm^2	5-6	3-4	8-10	7-8	2-3	1-2	3-4	2-3
Lymphatic postcapillaries	130.2±2.4	110.0±1.7	154.0±7.2	140.2±6.6	30.5±1.2	26.5±0.6	35.5±0.5	25.4±1.1
Lymphangions length	500-550	500-550	600-900	600-800	1200-1300	1000-1100	1500-1600	1400-1450
width	80-90	70-80	110-130	90-100	60-70	55-60	70-80	65-70
Distance between lymphatic capillaries and intestinal glands	25.2±2.1	35.0±2.5	49.55±2.10	58.3±4.3	—	—	—	—
Distance between lymphoid nodules and lymphatic capillaries	35.5±1.5	40.5±2.1	20.2±3.4	54.4±3.2	—	—	—	—

intestine and lymphatic network significantly differed in the early period of dehydration (Tables 1 and 2).

The density of the lymphatic network significantly decreased on day 6 of dehydration. During dehydration, morphometric parameters in the mucosa and submucosa decreased more significantly than in the muscle layer and serosa (by 1.8-1.9 and 1.1-1.2 times, respectively). Dehydration was accompanied by an increase in the distance between intestinal glands, lymphoid nodules, and lymphatic capillaries. Similar morphometric changes were found in other structures of the lymphatic network (Table 1).

The cell composition of solitary and aggregated lymphoid nodules (Peyer's patches) depended on the severity and duration of dehydration. The ratio of meiotic cells and immature plasma cells decreased by at least 3 times on day 6 of dehydration. The number of macrophages decreased by 1.4-1.5 times. Previous studies showed that the number of lymphoid nodules without germinal centers sharply increases in the spleen on day 6 of dehydration (as compared to that on day 3) [4]. The count of destructive cells progressively increased with increasing the duration of dehydration. We revealed a decrease in the density of cells per unit area (Tables 2 and 3).

Our results indicate that the water factor has a strong effect on the intraorgan lymphatic network and cell composition of lymphoid nodules. Water serves as a general biological solvent and essential component of living organisms. Water is constantly supplied from the external environment and forms an aqueous basis of the internal medium (blood, lymph, and tissue fluid) [1,3].

Problems of ecological lymphology and introduction of cellular technologies into lymphology require further investigations. It is necessary to perform detailed studies in the filed of lymphology and related areas.

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TABLE 2. Cellular Composition of Solitary Lymphoid Nodules without Germinal Centers in the Ileum during Dehydration (%, $X \pm Sx$)

Cells	Control	Period of dehydration, days		
		3	6	10
Large lymphocytes	10.4±0.4	7.5±0.2	6.9±0.6	4.9±0.4
Medium lymphocytes	18.3±1.2	16.4±1.1	15.6±0.4	13±0.2
Small lymphocytes	55.7±1.1	57.2±0.3	36.3±4.2	33.2±0.4
Mitoses	0.3±0.02	0.10±0.01	0.10±0.01	—
Immature plasma cells	1.6±0.2	1.1±0.4	0.5±0.1	0.30±0.01
Mature plasma cells	2.7±0.3	2.2±0.6	1.4±0.4	—
Macrophages	1.6±0.2	2.9±0.5	1.1±0.2	0.40±0.01
Mast cells	0.56±0.03	0.8±0.2	0.4±0.1	—
Reticular cells	7.4±0.4	7.2±0.3	6.5±0.2	5.8±0.2
Destructed cells	1.44±0.09	5.4±0.3	31.2±0.4	42.4±0.2
Cell density per unit area	37.4	34.2	31.2	25.8

TABLE 3. Cellular Composition of Aggregated Lymphoid Nodules in the Ileum of Albino Rats during Dehydration (%, $X \pm Sx$)

Cells	Control	Period of dehydration, days		
		3	6	10
Small lymphocytes	56.4±2.1	52.2±2.2	49.3±1.4	44.3±1.2
Medium lymphocytes	16.8±1.8	18.1±1.2	14.1±0.3	11.2±0.2
Large lymphocytes	10.2±1.2	11.3±1.5	8.1±0.2	6.90±0.01
Mitoses	0.40±0.02	0.6±0.1	0.20±0.01	—
Mature plasma cells	0.6±0.1	0.20±0.01	0.10±0.01	—
Immature plasma cells	1.7±0.2	1.40±0.02	0.90±0.01	0.40±0.01
Macrophages	2.9±0.3	3.8±0.4	2.5±0.2	1.20±0.02
Mast cells	0.5±0.1	1.1±0.2	1.40±0.02	—
Reticular cells	6.20±1.12	4.4±0.4	3.8±0.2	2.60±0.05
Destructed cells	3.7±0.4	7.8±0.6	18.6±1.2	33.4±0.2
Cell density per unit area	40.4	35.6	32.4	26.3

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