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Clinical and Morphological Aspects of the Functioning of the Lymphatic System

Mukhitdinova Khurshida Samikhovna
Department of Fundamental Medical Sciences, Asian International University, Bukhara

Abstract: The lymphatic system is directly involved in the exchange processes between blood and intercellular fluid, on the one hand, and intercellular fluid and cells on the other, that is, it serves as a medium connecting metabolic processes in the body. It is multifunctional. This article presents a new understanding of the morphology and functioning of the lymphatic system.

Keywords: Lymphatic system, spleen, thymus.

The third component of the unified cardiovascular system is the lymphatic system, which is the connecting link of all body fluids and plays an important role in maintaining homeostasis [8, 18, 24]. It includes lymphatic organs (nodes, follicles, tonsils, spleen, thymus) built from lymphoid tissue, and lymph transport pathways (capillaries, postcapillaries, micro- and macro vessels, sinuses).

The following extremely important functions can be distinguished:

1) maintaining the volume and composition of extracellular fluid;
2) resorption and transport into the general circulation of macromolecular substances synthesized in cells of parenchymal organs and endocrine glands (lymphocrine), as well as products of cellular metabolism and decay or impaired permeability of cellular and intracellular membranes trapped in the intercellular space;
3) resorption and transport of tissue fluid, plasma proteins and other large-molecular compounds that have left the vascular bed from the interstitial space into the general circulation;
4) participation in the protective reactions of the body and in the processes of hematopoiesis;
5) absorption and transport of lipids, water-soluble vitamins and other colloidal substances from the intestinal lumen into the venous system;
6) ensuring the humoral connection of the interstitial environment of all organs with the lymphoid apparatus, the implementation of the humoral connection of the interstitial environment with blood;
7) participation in the stress reactions of the body to extreme stimuli by transporting lymphocytes, plasmocytes and decay products migrating from lymphoid organs to the bone marrow and to the site of damage [18, 25, 28]. Thus, by freeing the internal environment of the body from excess water, proteins, fats, carbohydrates, electrolytes, enzymes, bacteria, cell breakdown products, toxins and constantly replenishing lymphocyte reserves, the lymphatic system takes an active part in maintaining homeostasis in general and immune homeostasis in particular.

MATERIALS AND METHODS

Unlike the circulatory system, the lymphatic system does not have an organ like the heart. The movement of lymph is an active process. The propulsive lymph-driving force in the lymphatic system is created by the so-called internal and external factors, designated by the term "lymphatic pump" ("the lymph pump") [18, 22, 24].

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Internal factors are the mechanisms and forces inherent in the lymphatic system itself that create lymph flow: the strength and magnitude of volumetric lymph formation, that is, the necessary volume without which lymph flow is impossible; structural and functional features of lymphatic vessels and their endothelium, the presence of valves in them, the tone and contractile activity of drugs and lymph nodes, rheological properties of lymph. An important internal factor of lymph flow is intraluminal pressure, while not only the absolute value of pressure is important, but also its gradient. A negative pressure gradient, i.e. the condition when the pressure at the outlet of the lymphangion becomes higher than the pressure at the inlet inhibits the pumping function. The opposite effect is observed with a positive pressure gradient. As a result, a variable hydraulic gradient is maintained in the lymphangion chains, providing conditions for constant stretching of the walls of lymphatic vessels and effective promotion of lymph into the circulatory system [3]. It is noteworthy that intravascular pressure is very closely related to another factor of lymph flow – phase contractile activity [22, 23]. Thus, lymphatic vessels respond to an increase in pressure (stretching of the walls) by increasing the strength and frequency of spontaneous phase contractions. The latter are a special type of contractile activity characteristic of the vessels of the lymphatic bed and represent rapid contractions of a separate section of the vessel, followed by rapid relaxation [13, 18]. In this case, individual myocytes of the smooth muscles of the lymphangion are involved in a synchronous contractile act by excitation of the pacemaker, which generates single action potentials that resemble the action potentials of the heart rhythm driver. At the same time, the value of intravascular pressure is the most likely trigger for a pacemaker [26]. Along with phase contractions, the work of the valves of lymphatic vessels is essential for the advancement of lymph, which, with short-term closure of the valves, can isolate lymphangions from each other and thus promote the pushing of lymph through the vessel in the centripetal direction [18]. With optical transmission microscopy, lymphocytes are visualized quite well in the lumen of lymphangions in the lymph flow, according to the movement of which attempts have been made to estimate the parameters of the lymph flow.

DISCUSSION.

So, there are three types of lymph flow:

1) jerky movement of lymphocytes, in which rapid translational movement is replaced by a much slower or short-term stop of lymph flow, after which the speed gradually increases, reaching its maximum value again;
2) moderate lymph flow;
3) pendulum-like (oscillatory) movement of lymphocytes without moving in the central direction [17]. Studies have shown that

The concentration of cells in the lymph flow is one of the important internal factors of the organization of lymph flow in microvessels and has a significant effect on the speed of lymph movement. Moreover, the rheological properties of the flow are optimal for lymphodynamics with a moderate number of cells in the flow [4]. External or extralymphatic factors include the functional state of the organ from which the lymph flows, activity cardiac and vascular smooth muscles, contractions of skeletal muscles, changes in arterial or venous pressure, fluctuations in intra-thoracic or intra-abdominal pressure, respiratory excursions of the chest and diaphragm, intestinal peristalsis, rhythmic contractions of the spleen, etc. [7, 11, 13, 18, 22, 27]. The problem of lymph formation is closely related to the issues of permeability of histohematic barriers. Therefore, when discussing the mechanisms of lymph formation, it is necessary to take into account a number of points:

1) the transfer of liquid and substances soluble in it from the blood capillaries into the intercellular space;
2) spreading of the material in the connective tissue;
3) resorption of capillary filtrate into the blood;

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4) resorption of proteins and excess fluid into the roots of the lymphatic system [7, 16, 19]. In the process of fluid transfer from tissues to lymphatic vessels, the main role is played by the mechanism of the "tissue-lymphatic pump". A decrease in tissue pressure leads to an expansion of the lymphatic capillaries, and its increase leads to a narrowing of the latter.

Dilation is created in the dilated lymphatic capillaries, followed by "suction" of the interstitial fluid. The size of the interendothelial gaps increases at the same time, ensuring the flow of liquid into the capillaries. In the phase of lymph moving through the vessel, endothelial cells close together, preventing the return flow of lymph. The movement of lymph through the lymphatic capillaries disrupts the balance between hydrostatic and colloidal osmotic pressures, predetermining the next cycle of lymph formation [19].

At the same time, R.A. Gareev [5] hypothesized about two types of lymph formation that depend on transcapillary metabolism.

The first, with zero or even negative interstitial pressure and the absence of interendothelial gaps in the lymphatic capillaries, is characterized by a diffusive transition of protein and other large–molecular compounds into the lymphatic channel in the presence of an appropriate protein concentration gradient between the lymph and the perilymphocapillary layer of free interstitial fluid.

The second type, with positive interstitial pressure and open interendothelial junctions of lymphatic capillaries, is characterized by the transition of interstitial fluid into the lymphatic channel due to the hydrostatic pressure difference. Such conditions are typical for hydrated tissues, and the mechanism of lymph formation corresponds to the filtration-resorption theory of lymph formation.

A new methodological approach to the assessment of the lymphatic system as a component of homeostasis in critical conditions is proposed in the literature [1]. First of all, the authors propose to combine all the reactions of the lymphatic system (including metabolic ones) under extreme conditions (prolonged crushing syndrome, experimental myocardial infarction) into the concept of lymphatic resetting. reseting – adjustment, adjustment), which refers to the systemic restructuring of structural and functional parameters to a qualitatively new level of life support, when the components of the lymphatic system take on additional functions that were previously unusual or unclaimed. Thus, instead of isolated reactions of the lymphatic system, an integral response arises, subordinate and aimed at implementing urgent adaptation to a stressor. The concept of lymphatic resetting allows, according to its creators, to emphasize the active role of the lymphatic system as an element of compensation and correction of disorders of the "metabolic profile" in critical conditions. As an integral part of lymphatic resetting, the phenomenon of lymphoattraction is distinguished (from Latin. attrachere – to attract), that is, the selective or selective accumulation of certain metabolites in the lymph and lymph nodes. Thus, the accumulation of magnesium and potassium ions in lymph nodes, zinc and manganese in lymph in extreme conditions cannot be explained only by the laws of simple mass transfer along the concentration gradient. Lymphoattraction probably serves as an auxiliary support for a particular plastic or energy function by components of the lymphatic system [2]. As can be seen from the above, the functional activity of the lymphatic system largely determines the implementation of the metabolic and trophic function of capillary-connective tissue structures: plastic and energy supply of cellular elements of organs and tissues, the intake of mediators and hormones into tissues. Therefore, the elucidation of the intimate mechanisms of adaptation of the body in different conditions of vital activity and in case of damage involves a thorough study of the functioning of this important link in the regulation of intercellular connective tissue spaces. Significant progress has been made in studying the pathology of the lymphatic system, its role in maintaining the constancy of the internal environment of the body and the consequences of disruption of its activity.

RESULTS

Modern lymphology has established that the lymphatic system, being one of the integrating systems of the body, in many diseases is involved in the pathological process both primary and secondary. Therefore, a violation of its functions affects the occurrence, development and outcome of diseases,

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since the drainage and detoxification function of the lymphatic system largely ensures the processes of sanogenesis in tissues. The above facts dictate the need to explore the possibilities of using new methods of direct or indirect effects on the lymphatic system in various types of pathology. The achievements of lymphology are increasingly being used in the clinic for lymphodiagnostics, lymphostimulation and lymphocorrection, which include lymphography, a set of surgical methods (drainage of the thoracic lymphatic duct with elements of lymphosorption, catheterization of peripheral lymphatic vessels for the purpose of infusion of drugs, lavage of the lymphatic system followed by removal of toxic lymph and extracorporeal ee purification, imposition of lymphvenous anastomoses, quantum autolymphotherapy, etc.)

It has been established that external lymphatic drainage, in which lymph loss is compensated without lymph reinfusion, causes moderate hypoproteinemia mainly due to low molecular weight proteins. The release of significant amounts of lymph may be the cause of profound changes in central hemodynamics. The removal of immunocompetent cells and immune protein complexes from the patient's body with lymph exacerbates the immunogenesis disorders already present in toxicosis. In addition, it has been experimentally proven that the administration of antibiotics inhibits the contractile activity and pumping function of smooth muscle cells of lymphatic vessels. At the same time, the combined use of drugs stimulating lymph flow and antibiotics, on the contrary, activates the contractile activity of lymphangions and thereby improves lymph circulation [2]. Most methods of lymphocorrection are at the stage of advancing the practical application of their theoretical justification.

CONCLUSION

Thus, the main problem of the development of modern teaching about the lymphatic system is an in-depth theoretical study of all its structures and functions in order to justify the need for lymphogenic therapy and the development of algorithms for targeted treatment of patients with various diseases and pathological processes.

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