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Morphology of intramural lymph vessels of the human heart

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Abstract

The structure of intraorgan system of the lymphatic collectors of the heart, their size, structure and distribution in different parts of the wall of lymphangions are described. Generation and interposition of muscle fibers in the structure of the common vessel are shown. Visual description of the interaction of different structures of the lymphatic system for lymph passage, from subendocardial lymph capillaries to the main outflow vessels is described.

Key words: lymphangions, lymphatic vessel, collector, caliber, form

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Introduction

Lymphangion is a structural-functional unit of a lymphatic vessel, which is a section of a lymphatic vessel between two valves (1-7). The peripheral valve of the lymphatic vessel belongs to one valve segment, the central one belongs to the next. According to the content of myocytes in the lymphangion, the muscular cuff, the wall of the valvular sinus and the region of attachment of the valve are distinguished (1-3,8,9). Myocytes are in close relationship with collagen and elastic fibers. To ensure the normal functioning of the heart, a significant role is played by the outflow of lymph from the heart. The subepicardial lymphatic vessels of the heart are a reservoir that collects lymph from all layers of the heart and are the lymphatic collector of the heart.

The concept of lymphangion as a structurally functional unit of a lymphatic vessel has been recognized by leading lymphologists of Russia (2,4).

The subepicardial lymphatic bed of the heart, which consists of the initial lymphatic networks, lymphatic vessels of the first order and larger lymphatic vessels of the second, third and fourth orders, has been studied. The latter, while merging, form the main or collector lymphatic vessels of the heart, heading to the regional lymph nodes. The outflow of lymph from the endocardium is carried out into the lymphatic channel of the myocardium and then into the "2-storied" subepicardial lymphatic network. The discharge lymphatic vessels are located subepicardially and accompany the branches of the coronary arteries along the anterior and posterior “longitudinal” grooves from the apex of the heart to the base. They form two main lymphatic “trunks” - the left and the right one, which flow into the regional lymph nodes of the mediastinum. The ventricular myocardium has lymphatic vessels that are connected on the one hand, with the subendocardial lymphatic network, and on the other hand with the subepicardial. All myocardial vessels flow into the plexus of the lymphatic vessels of the epicardium.

The lymphatic vessels of the atria and ventricles merge in the coronary sulcus, in the bifurcation node or in the nodes of the preaortocarotid lymphatic chain.

The shape of the lymphangions of the intraorgan vessels of the human heart is diverse, but most of them approach the shape of an ellipsoid.

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Lymphangions of intraorgan and extraorgan lymphatic vessels of the human heart have age and local features of the shape, size (length, width, volume), number and distribution of myocytes, bundles of collagen and elastic fibers (1,2,5).

It should be noted that vascular lymphangion in adulthood, elderly and senile ages is characterized by a significant variety of forms. The loops of the lymphatic capillaries of the myocardium in old age become diverse in shape and size. In connection with the problem of lymph transport from the heart, it is of considerable interest to study its lymphangions, the distribution of muscle elements in the area of the muscular cuff, valvular sinus and in the area of valve attachment. The decision was to study the quantitative parameters of lymphangion (length, width and volume), as well as the number, shape of lymphangions, the structure of its wall (myocytes, collagen and elastic fibers) of intraorgan and extraorgan lymphatic vessels of the heart in the postnatal period of ontogenesis.

The emphasizing of lymphangion as a structurally functional unit has made it possible to discover new aspects of the functioning of lymphatic vessels, first of all, to study their motor function. It is believed that the main factor in the lymphatic flow in the body is the contractile activity of the lymphatic vessels. Studying the structural foundations of the motor function of the lymphatic vessels of the human heart from a new perspective i.e. the theory of lymphangion is of undoubted interest to understand the lymph outflow from the wall of the human heart under normal and pathological conditions, therefore anatomical study of the human heart is not only of theoretical value, it is important for practical medicine, first of all cardiology. The ratio of the lymphatic bed of the heart to pathological developments has been proved by many authors. Therefore, their structural and functional state can be an integrating indicator of the lymph formation and lymph outflow from all the membranes of the heart (6,8).

The purpose of this study is to investigate the structure of intraorgan and extraorgan lymphatic vessels of the heart from the standpoint of the structural-functional unit of the lymphatic vessel, which is the lymphangion; to study the wall structure of lymphangions (myocytes, collagen and elastic fibers); to identify the dynamics of age-related changes in heart lymphangion; to identify partial atrophy of myocytes of the wall of the lymphangion, that reduces the motor function of lymphangion at the older age.

Methods

To solve the tasks, heart specimens taken from 15 corpses of people of both sexes who died from accidents and injuries were studied. Whenever possible, some specimens were taken in which there was less subepicardial fat that facilitated the accomplishment of subsequent study.

An injection technique revealed lymphatic capillaries, vessels of the left and right ventricles, as well as the atria. The wall structure was studied with morphometry of the subepicardial heart lymphangions.

In the study of architectonics of human heart lymphangions, complex methods of morphological studies were used. As a colored injection mass, a predominantly modified Herot mass was used. Herot's blue injection mass penetrates well into the lymphatic capillaries and lymphatic vessels. It quite easily reaches the regional lymph nodes, without diffusing from the lymphatic vessel into the surrounding tissue and, at the same time, contrasts well against the surrounding background, which is very valuable for the preparation (dissection) and microphotography of blood vessels.

The study of the lymphatic bed of the human heart through the method of interstitial injection and preparation made it possible to study in sufficient detail the formation and anatomical and topographic location of the left lymphatic collector of the heart and its regional lymph nodes.

In the study of the preparations made via the total drug technique, we can see all the structures of the lymphangion of the lymphatic vessel of the heart (valves, collagen and elastic fibers). Especially valuable color is gained in the treatment of the preparation with Heidengain azan, because at the same time, the cytoplasm of myocytes stains well in red or pink, and such dyes as gallocyanin, hematoxylin-eosin, picrofuxin, and Weiger resorcinol-fuchsin were also used.

The length and width of the lymphangions were determined after injection with a blue mass of Gerot. The length of the lymphangion on such preparations is the distance between the two constrictions of the lymphatic vessel. The width was determined in the middle part of the lymphangion.

Research methods were carried out in the following order:

1. The method of interstitial injection of colored mass (Herot mass).

2. The method of preparation.

3. The making of enlightened preparations according to the Shpaltegolts method as modified by D. A. Zhdanov, their conclusion in polystyrene according to the method of V. N. Nadezhdin

4. Production of histological sections and total preparations according to A.V., Borisov.

5. Methodology for the making of total preparations of the lymphatic vessels of the heart and hemomicrocirculation pathways.

6. Methodology for determining lymphangions per unit area of the epicardium.

7. The study of the ultrastructure of extraorgan lymphatic vessels of the heart of animals (10 white rats) by means of electron microscopy.

Results and Discussion

The lymphatic bed of the heart consists of lymphatic capillaries of the endocardium, myocardium and epicardium, lymphatic postcapillaries, intraorgan and extraorgan lymphatic vessels that flow into the regional lymph nodes. The main collector taking lymph from the endocardium and myocardium is the lymphatic bed of the epicardium, which consists of lymphatic capillaries, postcapillaries and blood vessels (Table 1).

Myocytes as the anatomical basis of the motor function of the lymphangion are determined in all the lymphangions of the vessels namely intraorgan, extraorgan "trunks" of the duct. In intraorgan lymphangions the number of myocytes is less than in extraorgan ones. In intraorgan lymphangions, myocytes are located in the middle part of the lymphangion (muscle cuff) and are usually absent in the wall of the valvular sinus (Table 2).

Table 1. Quantitative indicators of lymphangions (length, width, volume) of an intraorgan vessel in older people (75-90)

Lymphatic vessels of the 2nd order		
Length (mm)	Width (mm)	Volume (mm)
2.120(0.098)	0.650(0.068)	0.500(0.014)
Data are presented as Mean (SE)		

In extraorgan lymphangions, the number of myocytes in the muscle cuff is always greater than in the stack of valvular sinus. Myocytes are in close relationship with collagen and elastic fibers. Connective tissue fibers play a significant role in the motor function of the lymphangion. The elastic fibers of lymphangion in newborns and adults are thin. In the elderly, the elastic fibers of the wall of the lymphangion undergo profound changes: in some occasional areas, they get thicker, fragmented and disintegrated. In the elderly, varicose protrusions often formed in the wall of the valvular sinus of the lymphangion. Collagenization of the wall of the lymphangion and partial atrophy of the myocytes of the wall of the lymphangion in elderly people obviously reduce the motor function of the lymphangion at this age.

Table 2. The number of myocytes in the lymphangions of the left lymphatic collector of the human heart at the old age (75-90)

Object		minimum	maximum	M(SE)
Intraorgan	Muscular cuff	50	60	54.0(1.8)
	Valve sinus wall	0	0	0
	Valve attachment area	0	0	0
Extra-organ	Muscular cuff	100	130	121.0(5.5)
	Valve sinus wall	5	10	6.0(1.5)
		0	0	0

Conclusion

At the old age, significant changes occur in the shape, caliber and structure of the wall of the lymphangions of the intraorgan and extraorgan vessels of the left lymphatic collector of the heart. In this age group, “bay-shaped” and “mushroom-like” protrusions of the lymphangions of the intraorgan and extraorgan vessels are noted. Bulges are most often found in the wall of the valvular sinus of the lymphangions of the extraorgan vessel. The caliber of the lymphangions of the intraorgan and extraorgan vessels varies widely. The number of myocytes in the wall of the lymphangions of the intraorgan vessel is reduced. In parallel with the reduction (atrophy) of myocytes at this age, there occurs collagenization of the wall of the lymphangions i.e. an increase in the number of collagen fibers.

Conflict of interest: None to declare

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