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MORPHOLOGICAL ANALYSIS OF THE LYMPHATIC SYSTEM IN LUNG BRONCHIAL TISSUES DURING POSTNATAL ONTOGENESIS

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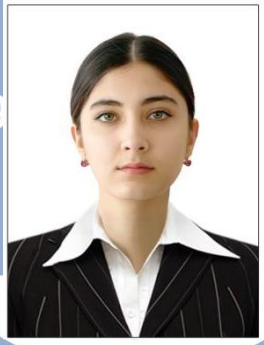

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Annotatsiya. *Ushbu maqolada postnatal ontogenezda o‘pka bronx to‘qimalari limfa tizimini morfologik shakllanishi va yosh davrlarida o‘zgarishini baholashni maqsad qilib olindi. Tekshiruv Respublika patalogik anatomiya markazida va Surhondaryo patologik anatomiya byurosida 2023-2025 yil I -chorakda qabul qilingan postnatal ontogenezda vafot etgan odam murdalari ustida olib borildi.*

Tadqiqot natijasida, barcha yosh guruhlarida o‘pkaning limfa tomirlari ineksion massa yuborilganda: avval yuza qismdagilar, keyin esa chuqurroqdagilar to‘lib borishi aniqlandi.

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Xulosamizda: Limfa kapillyarlari o‘pka bo‘lakchalari ichida aniqlanadi va bu erda ular yagona murakkab perivaskulyar hamda peribronxial to‘rni hosil qiladi. Bir qavatli to‘rdan ikki qavatli to‘rga o‘tish asta-sekin sodir bo‘ladi.

Kalit so‘zlar: *Postnatal ontogenez, limfa kapillyari, bronxiola, gistokimyo, morfometriya, diametr.*

Аннотация. *Целью данной статьи является оценка морфологического формирования и возрастных изменений лимфатической системы бронхиальной ткани легких в постнатальном онтогенезе. Исследование проводилось на трупах людей, умерших в постнатальном периоде, поступивших в Республиканский центр патологической анатомии и Сурхандарьинское бюро патологической анатомии в I квартале 2023-2025 гг.*

В результате исследования было установлено, что во всех возрастных группах при введении инъекционной массы лимфатические сосуды легких наполняются: сначала поверхностные, а затем более глубокие. Заключение: Лимфатические капилляры обнаруживаются внутри долек легкого, где они образуют единую сложную перивaскулярную и перибронхиальную сеть. Переход от однослойной сети к двухслойной происходит постепенно.

Ключевые слова: Постнатальный онтогенез, лимфатические капилляры, бронхиолы, гистохимия, морфометрия, диаметр.

Annotation*: This article aims to assess the morphological formation and age-related changes in the lymphatic system of lung bronchial tissues during postnatal ontogenesis. The study was conducted at the Republican Center of Pathological Anatomy and the Surkhandarya Bureau of Pathological Anatomy on human cadavers who died during postnatal ontogenesis in the first quarter of 2023-2025.*

The research results showed that in all age groups, when injection mass was administered to the pulmonary lymphatic vessels, they filled in a specific order: first in the superficial part, and then in the deeper part. In conclusion: Lymph capillaries are detected within the lung lobules, where they form a single complex perivascular and peribronchial network. The transition from a single-layer network to a double-layer network occurs gradually.

Keywords: *Postnatal ontogenesis, lymphatic capillaries, bronchioles, histochemistry, morphometry, diameter.*

The relevance of the problem: Rapid advancements in the field of prenatal medicine have led to an increase in various tracheobronchial interventions on the respiratory organs of fetuses and newborns. Studying the patterns of respiratory system organogenesis allows for a better understanding of the etiopathogenesis of congenital defects and the reasons for the emergence of structural variations in its components.

The lymphatic system plays a crucial role in the body's vital functions. It is known that the lymphatic system participates in water-salt, protein, and fat metabolism, as well as in the transport of hormones and enzymes. Additionally, it performs drainage and protective functions**.**

As V. V. Kupriyanov and co-authors emphasized, the lymphatic system is an essential component of the entire pulmonary vascular system and participates in all vital processes.

From the earliest days of lymphatic system research, the importance of microlymphology became evident: its development, structure, and function determine the structural and functional characteristics of organs, as well as the metabolism of tissues and cells. Similar to the microcirculatory system, the microlymphatic channel forms one of the three main components of the lymphatic system and serves as its central part. The structural features of the microlymphatic channel ensure the balance of interstitial fluid and maintain the constant functioning of the organ's structural and functional units, including its constituent cells and tissues. It absorbs cellular metabolic products, fats, and large proteins, facilitating the flow of lymph and blood along arterial and venous capillaries.

This process guarantees the balance of metabolism and ensures a stable flow of interstitial fluid to the corresponding capillaries.

D. A. Zhdanov considered the relationship of lymphatic capillaries to blood capillaries and structural elements of organs to be the fundamental issue in the morphology and physiology of the lymphatic system.

A detailed study of the lymphatic system's structure in each organ, particularly in the lungs, enables us to identify the general and specific patterns of its structural organization, the interconnections between various components, the pathways of lymph flow, age-related characteristics in bronchi of different calibers, and variations in how lymphatic vessels drain into regional lymph nodes.

Yu. I. Borodin and colleagues emphasize that mastering the principles of lymphatic system functioning in organs ultimately leads to the ability to control processes occurring in both physiological and pathological states. This, specifically, means regulating lymph production.

In the second half of the 19th century, it was proven that lymphatic vessels first appeared in fish, as demonstrated using the injection method. This process was shown to be connected with the formation of a closed circulatory system.

A similar method, employed by S. Vandet Putte in studying the postembryonic development of the lymphatic system in 40 human fetuses aged 35 to 65 days, allowed for the identification of very early formation of the lymphatic system.

Taking the above into consideration, it is imperative to conduct research focused on studying the morphological development of the lymphatic system in lung bronchial tissues during postnatal ontogenesis.

Purpose of the study: It involves assessing the morphological formation of the lymphatic system in lung bronchial tissues during postnatal ontogenesis and its changes across age periods.

Methods and Materials for Testing: The study was conducted at the Republican Center of Pathological Anatomy and the Surkhandarya Bureau of Pathological Anatomy on human cadavers who died during postnatal ontogenesis in the first quarter of 2023-2025. The research focused on individuals who died due to various factors but without changes in the respiratory system, primarily those who succumbed to heart defects and other causes without diseases of the bronchial passages of the lungs. The causes of death and the underlying diseases were determined through pathological anatomy conclusions. Examination materials were obtained from the following parts of the lungs: autopsy samples were taken from the apex of the lung, the hilar region of the lung, and lymphatic vessels and nodules located in the tissues of the lower lobe of the lung. Our study employed instrumental (using calipers), general histological, histochemical, morphometric, and statistical research methods. The obtained materials were fixed in formalin, and subsequently, 3-5 µm sections were prepared. These sections were subjected to injection methods using Gerot's mass. See Figure 1.

	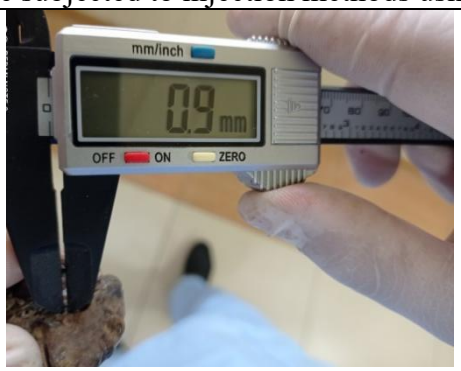	
a	b	v

Figure 1. Measuring the bronchi of a one-month-old infant using an electronic caliper. (a - measuring the thickness of the bronchial wall of a one-month-old infant, b - measuring the inner diameter of the bronchi in the lungs of a one-month-old infant, v - measuring the mass of the right lung lobe of a one-month-old infant).

Results of the study: The researchers' particular focus on the lymphatic and circulatory systems arises from the necessity to uncover their biological significance, adaptive capabilities, and involvement in physiological and pathological processes.

Data on ontogenesis and phylogenesis demonstrate that the microcirculatory system develops simultaneously with the formation of a living organism's body. In highly evolved animals and humans, the three components of microcirculation - hemomicrocirculatory, lymphatic, and interstitial fluid exchange - interact dynamically. These interconnected components maintain homeostasis and possess significant adaptive capabilities.

Our research has demonstrated that in all age groups, following the administration of the injection mass, the lymphatic vessels of the lungs fill in a specific order: first in the superficial region, then in the deeper areas. This observation indicates the presence of anastomoses between the peribronchial network of lymphatic vessels and the lymphatic capillaries of the mucous membrane. Such a structure ensures the independent flow of lymph in both directions during respiratory movements.

Interconnecting fragments of peribronchial lymphatic capillaries extend in a caudal direction into the submucosal capillary network of the bronchus, which can have a diameter of 0.5-1.0 mm. Outside the first submucosal network of lymphatic capillaries, a second, peribronchial network of lymphatic capillaries gradually forms. Thus, at the lobular level, a single complex network of lymphatic capillaries is identified. Below the lobular level, a double network of interconnecting lymphatic capillaries is distinguished, both submucosal and peribronchial. The transition from a single network of lymphatic capillaries (within the lobules) to two networks occurs gradually and imperceptibly.

When examining the bronchus longitudinally, the longitudinal arrangement of lymphatic capillaries 1 and 2 draws attention. Circular capillaries of various shapes from the surrounding connective tissue drain into these capillaries. The rings of the lymphatic capillaries are positioned at different angles relative to the collector vessel, ranging from 5-10 degrees to 90 degrees and beyond.

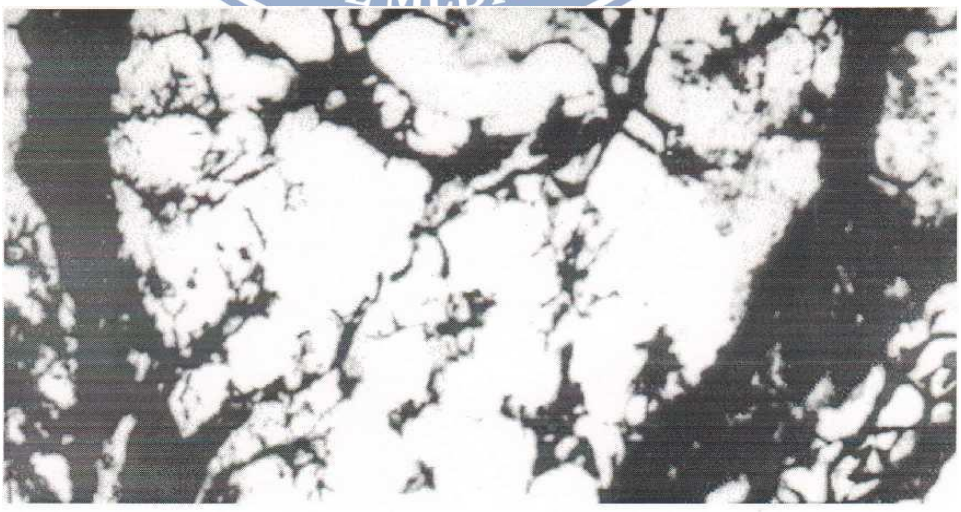

Figure 1. A network of lymphatic capillaries of various shapes and sizes in the submucosal and peribronchial areas of a child during early childhood. Gerot's mass has been administered. Magnified 20 times.

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Figure 2. Longitudinal arrangement of lymphatic capillaries during adolescence and various shaped rings that drain into them. Injected with Gerot's mass. Magnified 15 times.

Dynamics of changes in the diameter of lymphatic capillaries and the rings formed by them in the submucosal layer of the bronchi with a diameter of 0.5 mm depending on age (maximum - minimum values, in mm)

Table-1.

Age periods		Lymphatic capillary diameter	Diameter of lymph capillary rings
Infants		0,019-0,036	0,150x0,260-0,150x0,160
Infancy		0,016-0,027	0,150x0,305-0,150x0,180
Early childhood		0,021-0,045	0,150x0,300-0,150x0,190
First childhood		0,024-0,032	0,250x0,450-0,250x0,240
Second childhood		0,023-0,041	0,270x0,380-0,270x0,250
Adolescence		0,016-0,032	0,270x0,370-0,260x0,300
Youth		0,021-0,042	0,290x0,380-0,270x0,450
Maturity period	Stage I	0,017-0,047	0,260x0,420-0,210x0,380
	Stage II	0,015-0,045	0,270x0,410-0,170x0,190
Old age		0,018-0,041	0,180x0,330-0,130x0,290
Old age		0,025-0,043	0,250x0,410-0,220x0,380

During the study of lymphatic capillaries in small bronchi with diameters of 0.5-1.5 mm, the presence of submucosal and peribronchial networks was observed in all age periods (Figure 1). The submucosal layer forms rings of oval, round, rectangular, and polygonal shapes. At the junctions, capillaries create triangular or rectangular spaces.

Dynamics of changes in the diameter of lymphatic capillaries and the rings formed by them in the submucosal layer of the bronchi with a diameter of 1.5 mm (maximum - minimum mm) depending on age

Table-2.

Age periods		Lymphatic capillary diameter	Diameter of lymph capillary rings
Infants		0,028-0,046	0,140x0,670-0,140x0,450
Infancy		0,025-0,050	0,150x0,700-0,140x0,650
Early childhood		0,027-0,055	0,150x0,750-0,120x0,700
First childhood		0,030-0,055	0,250x0,850-0,130x0,700
Second childhood		0,030-0,055	0,275x0,850-0,155x0,675
Adolescence		0,035-0,055	0,255x0,750-0,125x0,650
Youth		0,030-0,060	0,350x0,650-0,300x0,600
Maturity period	Stage I	0,025-0,060	0,350x0,700-0,250x0,750
	Stage II	0,025-0,560	0,350x0,700-0,350x0,600
Old age		0,025-0,050	0,350x0,650-0,350x0,550
Old age		0,020-0,055	0,275x0,575-0,250x0,750

In the submucosal layer of the small bronchi (up to 5 mm), the diameter of the lymphatic capillary network and the size of the formed rings are small (Table 2). In newborns, they measure 0.027±0.003 mm and 0.0375±0.0012 mm2 respectively. With age, the average values of the ring diameters do not change significantly, but their variability increases. At birth, the diameter of the rings ranged from 0.018 to 0.036 mm, and with age, it increased to 0.015-0.045 mm (second mature age). The same can be noted in the determination as well.

Conclusion: The conclusion of the study is as follows: Lymphatic capillaries are identified within the lung lobules, where they form a single complex perivascular and peribronchial network. A series of lymphatic capillaries originating from the peribronchial network extends along the interlobular septa and forms anastomoses with superficially located lymphatic capillaries. Above the level of the lobules, the complex anastomosing network of lymphatic capillaries in the submucosa becomes two-layered. The transition from a single-layer network to a double-layer network occurs gradually. The described structure of the lymphatic capillaries is clearly observable from the first year of a child's life through adolescence.

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