

## Clinical anatomy of pulmonary connections in young people

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### ABSTRACT

**Aim:** To study the clinical anatomy of the pulmonary ligaments of young people.

**Materials and Methods:** The study was carried out when performing 28 autopsies of young people aged 25 to 44 years. Methods of dissection of chest organocomplexes, macro-microscopy, morphometry and planimetry, and statistical processing were used. The shape and topography of the pulmonary ligaments was assessed, their area, the localization of lymph nodes was examined.

**Results:** The pulmonary ligament is an anatomical formation, which is formed as a result of a combination of leaves of the mediastinal pleura, which, covering the surfaces of the roots of the lungs, descend towards the diaphragm and are located between the mediastinal organs and the lungs. Pulmonary connections on both sides have a few edges: the inner, outer and lower free. The pulmonary ligaments with lower free edges do not pass to the diaphragmatic surface of the pleura, but only with inner ones, which are located on the right along the esophagus, and on the left along the aorta. Pulmonary ligaments on both sides pass into the mediastinal part of the pleura, covering the pericardium.

**Conclusions:** There are individual differences between the shape and size of the right and left pulmonary ligaments in males and females. There is no significant difference between the sizes of the right and left pulmonary ligaments, but such dimensions as: the width, the angle of indination and the ratio of their lower free edge to the lower edge of the lungs are not found in all cases.

**KEY WORDS:** young age, people, clinical anatomy, pulmonary ligaments

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## INTRODUCTION

Respiratory diseases remain a very common pathology in the morbidity structure of the population of Ukraine and an important health problem due to their frequency among the working population and children, a combination of various lung pathologies and a negative impact on concomitant diseases, and the development of disability [1-3]. Thus, the average duration of treatment of a patient in the thoracic department is 15.2 days, and the mortality rate from chronic diseases of the lower respiratory tract reaches 12.6 (per 100,000 populations).

In recent years, more and more attention has been paid to improving the methods of surgical treatment of pathology of the lungs and mediastinal organs. At the same time, they also mention the pulmonary ligament, the expediency of its intersection and ligation during both open and video-assisted thoracoscopic surgical interventions [4]. However, in modern scientific literature there is practically no data on the size, shape, structure and anatomy of the pulmonary ligaments in people, the

differences between them on the left and right, their age and gender characteristics. Definitions, which are mainly found in scientific works devoted to surgical interventions on the lungs, indicate that the pulmonary ligament is a two-layer pleural structure connecting the visceral pleura in the lower medial part of the lung with the parietal pleura, which extends sheet-like down from the level of the inferior pulmonary vein to the diaphragmatic pleura, where it is either fixed or ends with a free crescent-shaped edge [5]. Some authors call it the inferior pulmonary ligament [6, 7]. However, its size, content and features of placement both on the left and on the right in people of all ages are not discussed in scientific works of anatomical or surgical directions.

In the literature, much more attention is paid to studying its role during surgical interventions, especially when performing upper lobectomy using video-assisted thoracoscopic surgery in the early stage of lung cancer [6]. Some thoracic surgeons believe that incision of the inferior pulmonary ligament during an upper lobectomy leads to positive postoperative

results of lung expansion, reduction of pleural effusion, and prevention of atelectasis [7]. However, there are reports that excessive lung expansion can lead to serious changes in the angle of the bronchi, which ultimately causes their deformation [8]. Other surgeons believe that the preservation of the lower pulmonary ligaments during surgery may be beneficial in terms of postoperative pleural fluid drainage by ensuring normal lymphatic drainage [5] and to expand the left lower lobe and reduce movement and repositioning of the left main bronchus [6].

With the development of lung cancer and the occurrence of metastases, it is proposed to perform an approach through the inferior pulmonary ligament to perform resection of the posterior or lateral basal segments. With such approaches, surgical trauma and postoperative complications are reduced [2]. However, it requires surgeons to know a clear definition of anatomical structures and the best surgical skills [9, 10].

So, given that in the available modern scientific literature there is no data on the size and clinical anatomy of the pulmonary ligaments in people, we set out to conduct a study aimed at determining the size, shape, area, content and syntopy of the left and right pulmonary ligaments in people. young age is normal, contributing to the improvement of surgical interventions on the lungs and mediastinal organs. Their study began with people aged 25 to 44 years, which, according to the latest WHO classification, is considered young. We also hope that these studies will to some extent fill the gap in the clinical anatomy of the pulmonary ligaments of young people.

## AIM

The aim of this research was to study the size, shape, area, content and clinical anatomy of the left and right pulmonary ligaments in young people.

## MATERIALS AND METHODS

When writing the article, the following methods were used: bibliosemantic, content analysis, statistical, macroscopic analysis. Macroscopic studies were carried out on preparations of the chest organs during 28 autopsies of young people aged 25 to 44 years who died from various causes at the Poltava Regional Pathological Anatomical Bureau (inclusion criterion – young age of the person (25–44 years according to the WHO classification) Among persons of this age period, there were 15 male and 13 female specimens, their average age was  $39.3 \pm 2.4$  years. In this study, methods were used for dissecting organ complexes of the breast in order

to access macroscopic preparations of the pulmonary ligaments, macroscopy, and macro-microscopy according to V.P. Vorobyov, syntopy of pulmonary ligaments, morphometry and planimetry of pulmonary ligaments, statistical processing of quantitative data.

Before opening the chest, the trachea was clamped with a clamp to prevent the decrease of the lungs. For a better study, the preparation of organocomplexes on both sides was performed, followed by the study of the right and left pulmonary ligaments. When conducting a study using a caliper, the height was measured from the apex at the lower semicircle of the inferior pulmonary vein to the middle of its base, the width at the upper edge, in the middle and along the lower edge. An anthropometric conveyor was used to determine the angles of deviation of the pulmonary ligaments from the frontal plane. The distance from the lower edge of the pulmonary ligaments in the lung to the lower edge of the lower particles was also measured, and when they passed to the diaphragmatic surface, this distance was determined. The distance from the lower edge of the pulmonary ligaments in the lung to the lower edge of the lower particles was measured. Attention was paid to in which cases the pulmonary ligaments with their pulmonary edge reached the lower edge of the lower part of the lungs, and in which cases they did not reach or passed to their diaphragmatic surface and measured this distance. The shape of the pulmonary ligaments was assessed, after their excision they were stretched on millimeter paper, outlined and the area was determined, after which their content was examined. The number and location of lymph nodes in them were determined.

We studied the topography of the left and right pulmonary ligaments in relation to the inferior pulmonary veins, the lower edge and diaphragmatic surface of the lower lobes of the lungs, the esophagus with the vagus nerves, the descending part of the thoracic aorta, the pericardium, and the diaphragm.

The obtained digital material of the research results was subjected to statistical processing using the Statistica 9.0 program and a comparison of average indicators between the right and left pulmonary ligaments of men and women was carried out. The results were considered statistically significant at  $p < 0.05$ .

## RESULTS

Upon receipt of the results of the study, it was established that in young people, pulmonary ligaments are a doubling of the mediastinal part of the parietal pleura, which passes into the pulmonary pleura and covers the roots of the left and right lungs along the anterior and

posterior surfaces. Below the roots of the lungs, these two sheets do not immediately converge and are placed between the organs of the mediastinum and the lower lobe of the lungs, forming the pulmonary ligament. The tops of these ligaments are below the inferior pulmonary vein, although the latter is sometimes placed between its leaves. This must be taken into account by surgeons when accessing the root of the lungs, when performing surgical interventions on the lungs, such as lower lobe lobectomy or pneumonectomy, and mediastinal organs.

When studying topographic anatomy, it was found that the inner edges of the pulmonary ligaments, both on the right and on the left, are located at the nearby sections of the esophagus and aorta, and then they go to the mediastinal surface of the lower particles, where they pass into its pulmonary pleura. Pulmonary ligaments on both sides, except for the apex, have two edges: the inner or mediastinal and outer, or pulmonary and lower free edge, hanging over the diaphragm. Between the lower edge of the pulmonary ligaments and the diaphragm there is a certain gap, the height of which depends on the distance at which the ligaments with their outer edge pass into the pulmonary pleura of the lower lobe of the lungs. So, the higher the diaphragmatic surface of the lung, the lower edge of the ligaments passes into the pulmonary pleura, the greater the height of this gap, and the lower, the smaller its height. Pulmonary ligaments with their lower free edges from the outside do not pass to the diaphragmatic surface of the pleura, but only with their inner edge, located on the right along the esophagus, and on the left – along the aorta, can continue into the diaphragmatic part of the pleura. Pulmonary ligaments with the inner edge of the anterior leaf on both sides pass into the mediastinal part of the pleura, covering the pericardium. However, in one (3.6%) female person, the anterior and posterior sheets of the pulmonary ligament passed into the mediastinal part of the parietal pleura that covered the pericardium. The right pulmonary ligaments in people from the inner edge also passed into the mediastinal part of the parietal pleura, which covered the pericardium, and the back leaf – in the mediastinal part of the parietal pleura that covered the esophagus. In two (7.1%) preparations (male and female), both sheets from the inner edge passed into the mediastinal part of the parietal pleura, which covered the thoracic part of the esophagus. In 11 (73.3%) men, the left and in 8 (53.3%) men, the right pulmonary ligaments from the side of the mediastinum with their lower edge passed into the pleura, which covered the diaphragm. Such a transition of the pulmonary ligaments into the diaphragmatic part of the parietal pleura in females was observed in 7 (53.8%) cases on the left and in 9 (69.2%) cases on the

right. In one (7.7%) female preparation, a transition of the posterior leaf of the pulmonary ligament on one side to the posterior leaf of the pulmonary ligament of the opposite side was detected.

When studying the question of what shape of the pulmonary ligaments young people have, it was found that 10 (66.7%) of the left pulmonary ligaments of the male subjects had a triangular, 4 (26.7%) – trapezoid and 1 (6.7%) – quadrangular forms. On the right side, 8 (53.4%) pulmonary ligaments were triangular, 5 (33.3%) were quadrangular, and 2 (13.3%) were trapezoidal. Among women, 9 (69.2%) had a triangular shape, 3 (23.1%) trapezoidal, and 1 (7.7%) quadrangular left pulmonary ligaments.

The right pulmonary ligaments were distributed in shape as follows: 6 (46.1%) were triangular, 4 (30.8%) were quadrangular and 3 (23.1%) were trapezoidal. That is, 19 (67.9%) left and 14 (50.0%) right ones had a triangular shape, 7 (25.0%) left and 5 (17.9%) right ones had a trapezoidal shape, and 2 (7.1%) left and 9 (32.1%) right pulmonary ligaments.

Research continued by measuring the height of the pulmonary ligaments. Thus, the average height of the left pulmonary ligaments in young people was  $58.4 \pm 3.2$  mm, and the right ones –  $54.5 \pm 2.8$  mm ( $p > 0.05$ ).

The width of the pulmonary ligaments was also measured at three levels: along the upper and lower edges and in the middle of the height. Only trapezoidal and quadrangular pulmonary ligaments had width at the upper edge. The average width at the center of the height of the left pulmonary ligaments was  $27.7 \pm 3.4$  mm, and that of the right ones –  $30.9 \pm 3.2$  mm ( $p > 0.05$ ). The width at the lower edge of the left pulmonary ligaments in young people averaged  $48.9 \pm 3.7$  mm, and the average value of the same indicator for the right pulmonary ligaments was  $51.3 \pm 3.2$  mm ( $p > 0.05$ ).

The areas of the pulmonary ligaments were determined using the planimetric method. Thus, the average area of the left pulmonary ligaments was  $1008.9 \pm 110.5$  mm<sup>2</sup>, and that of the right ones was  $1138.6 \pm 115.3$  mm<sup>2</sup> ( $p > 0.05$ ).

Data on the average height, width of the left and right pulmonary ligaments at different levels and their areas in young men and women are shown in Table 1.

In young males, 4 (14.3%) left and 6 (21.4%) right pulmonary ligaments did not reach the lower edge of the lower lobe of the lungs, and 2 (7.1%) left and 3 (10.7%) of the right pulmonary ligaments passed to the diaphragmatic surface of the lower particles of the lungs. In women, on the left, 5 (17.9%) pulmonary ligaments did not reach and 7 (25.0%) – passed to the diaphragmatic surface of the lower lobes, and on the right, 5 (17.9%) pulmonary ligaments passed and 8 (28.6%) did not reach the diaphragmatic surface of

**Table 1.** Average sizes of pulmonary ligaments in young male and female people

No.	Average indicator sizes	Pulmonary ligaments in young people				Confidence level (p)
		men		women		
		left	right	left	right	
1.	height of pulmonary ligaments (mm)	60,7±3,4	57,6±3,3	56,2±2,9	51,8±3,1	p <sub>1</sub> > 0,05 p <sub>2</sub> > 0,05
2.	width of pulmonary ligaments at the upper edge (mm)	12,1±3,2	15,5±3,2	11,3±2,7	13,7±2,6	p <sub>1</sub> < 0,05 p <sub>2</sub> < 0,05
3.	width of pulmonary ligaments at mid-height (mm)	28,6±2,9	30,1±2,8	26,7±3,1	29,2±2,7	p <sub>1</sub> > 0,05 p <sub>2</sub> > 0,05
4.	width of pulmonary ligaments at the lower edge (mm)	49,6±3,2	52,1±3,3	47,4±2,9	48,3±2,8	p <sub>1</sub> > 0,05 p <sub>2</sub> > 0,05
5.	area of pulmonary ligaments (mm2)	1124,6 ± 109,8	1184,3± 116,4	887,5± 103,6	975,4± 99,8	p <sub>1</sub> < 0,05 p <sub>2</sub> > 0,05

Note:  $p_1$  – level of reliability of average indicators of the sizes of the left pulmonary ligaments between men and women;  $p_2$  – level of reliability of average indicators of the sizes of the right pulmonary ligaments between men and women.

the lower particles of the lungs. The average distance from the lower edge of the left pulmonary ligaments to the lower edge of the lower particles of the lungs in males was  $4.7 \pm 1.8$  mm, and in females –  $8.9 \pm 2.8$  mm ( $p < 0.05$ ), which among all left ligaments, the average was  $6.8 \pm 2.5$  mm. The average distance from the lower edge of the right pulmonary ligaments to the lower edge of the lower particles of the lungs was  $4.4 \pm 1.3$  mm, in men it averaged  $2.8 \pm 1.1$  mm, and in women it was  $5.7 \pm 1.9$  mm ( $p < 0.05$ ).

Upon further study, it was revealed that some pulmonary ligaments passed from top to bottom with a backward deviation from the frontal plane. This feature of the passage of the left pulmonary ligaments was observed in 11 (39.3%) cases, of which 5 (33.3%) men and 6 (46.2%) women. The angle of deviation of the ligaments from the frontal plane was also measured. It averaged  $20.3 \pm 4.5$  in males and  $29.8 \pm 3.9$  in females ( $p < 0.05$ ). In 6 (21.4%) men and 8 (28.6%) women, the pulmonary ligaments deviated backward from the frontal plane, while the average angles of deviation were  $18.9 \pm 3.6$  in men and  $27.7 \pm 4.1$  – in women ( $p < 0.05$ ).

However, such dimensions as: width at the upper edge, the angle of inclination of the pulmonary ligaments back from the frontal plane and the ratio of their lower free edge to the lower edge of the lower particles of the lungs are not found in all pulmonary ligaments of young people.

According to the data obtained in men, the inferior pulmonary vein was located in the thickness of 4 (14.3%) of the left and 2 (7.1%) of the right pulmonary ligaments. In females, such placement of the inferior pulmonary vein was observed in 2 (7.1%) cases on the left and in one (3.6%) on the right. In such preparations, the distance from the upper edge of the pulmonary ligaments to the upper semicircle of the inferior pul-

monary veins was measured. The average value of this distance in men is  $2.1 \pm 0.5$  mm on the left and  $1.8 \pm 0.7$  mm on the right ( $p > 0.05$ ). And the average distance between the top of the pulmonary ligaments and the upper semicircle of the lower pulmonary veins in young women is  $2.0 \pm 0.2$  mm on the left and  $1.5 \pm 0.4$  mm on the right.

During dissection, lymph nodes of various sizes were found in the thickness of the pulmonary ligaments. So, in the thickness of 12 (42.9%) of the left pulmonary ligaments, 23 lymph nodes were found, of which 11 lymph nodes were found in men on the left in the thickness of 5 (33.3%) ligaments: 4 at the apex, 3 in the middle of the height and 5 at the lower edge pulmonary ligaments. In females, in the thickness of 7 (53.8%) of the left pulmonary ligaments, 5 lymph nodes were located at the upper and lower edges and 2 in the middle of the height. Examination of 13 (46.4%) right pulmonary ligaments revealed 22 lymph nodes between their sheets. In 8 (53.3%) males, in the thickness of the right pulmonary ligaments at the upper edge and in the middle of the height there were 3 lymph nodes and at the lower edge – 6 lymph nodes. And in women, 5 (38.5%) of the right pulmonary ligaments in their thickness had 10 lymph nodes, which were located: at the upper edge – 2 and in the middle of the height and at the lower edge – 4 each. When conducting a macro-microscopic study, it was found that between the leaves of the pulmonary ligaments in the loose connective tissue, in addition to the lymph nodes, are blood vessels and bundles of nerve fibers, limited by the perineurium.

## DISCUSSION

According to the data obtained, the pulmonary ligament of young people is a doubling of the pleura,

which forms below the root of the lungs and stretches to the diaphragmatic pleura and connects the visceral pleura to the mediastinal pleura in the lower part of the lung. These results of the study coincide with the data of other authors [12]. However, we do not agree with the data of scientists who call the pulmonary ligament inferior [6, 7], since a person does not have other pulmonary ligaments, including the upper ones, and they exist only on the right and left.

The pulmonary ligaments with their lower free edges from the outside do not pass to the diaphragmatic surface of the pleura, but with their inner edges, which are located on the right along the esophagus, and on the left along the aorta, they can continue into the diaphragmatic part of the pleura. The pulmonary ligaments, with the inner edge of the anterior leaf on both sides, pass into the mediastinal part of the pleura, covering the pericardium.

Lymph nodes of different sizes were found in the thickness of the pulmonary ligaments at different levels, which indicates the existence of sufficient lymphatic drainage, which plays a significant role in the outflow of pleural fluid after surgical interventions on the lungs and mediastinal organs. This confirms the opinion of other scientists about the advisability of preserving the lower pulmonary ligaments when performing surgical interventions for postoperative outflow of pleural fluid [5].

In this scientific study, the forms and average sizes of the pulmonary ligaments in young males and females were established. The features of the transition of the inner, outer and lower edges of these ligaments to the mediastinal, visceral and diaphragmatic parts of the pleura are indicated. So, the pulmonary ligaments, with their inner edges of the back sheet, pass into the mediastinal pleura, covering the esophagus on the right, and the thoracic aorta on the left. With the inner edge of the anterior sheet, the pulmonary ligaments on both sides pass into the mediastinal part of the pleura covering the pericardium, and the lower edge can continue into the

diaphragmatic part of the pleura. Also, during the study, an interesting feature of the placement in the thickness of the left and right pulmonary ligaments of the lower pulmonary vein in some young males and females was revealed. All these data must be taken into account when performing accesses through the pulmonary ligaments to the root of the lungs, when performing open and video-assisted thoracoscopic operations, as some authors point out in their scientific articles [4, 7, 8], as well as when performing upper lobectomy at an early stage of lung cancer [6] and resection of the posterior or lateral basal segments [11].

Thus, to improve the results of performing surgical interventions on the lung root, lower lobe, lungs and mediastinal organs, it is necessary to have a clear knowledge of the clinical anatomy of the chest organs and pulmonary ligaments.

## CONCLUSIONS

Thus, the size, shape, area, content and clinical anatomy of the left and right pulmonary ligaments in young people were studied. It has been established that in young people there are individual differences between the shape and size of the right and left pulmonary ligaments in males and females. In most cases, there was no significant difference ( $p > 0.05$ ) between the values of different sizes of the right and left pulmonary ligaments. It was revealed that the upper edge of these ligaments is located below the inferior pulmonary vein, although the latter one in 4 (14.3%) cases on the left and in 2 (7.1%) on the right is located between its leaves. In the thickness of 12 (42.9%) left pulmonary ligaments there were 23 lymph nodes at different levels, and between the layers of 13 (46.4%) right pulmonary ligaments there were 22 lymph nodes. In addition to the lymph nodes, between the leaves of the pulmonary ligaments in the loose connective tissue there are blood vessels and bundles of nerve fibers.

## REFERENCES

1. Bielikova IV, Pluzhnikova TV, Krasnova OI et al. Analysis of morbidity and disability among children in the city of Poltava. *Wiad Lek.* 2020;73(6):1296-1299. doi: 10.36740/WLek202006142. DOI
2. Bousquet J, Anto JM, Bachert C et al. ARIA digital anamorphosis: Digital transformation of health and care in airway diseases from research to practice. *Allergy.* 2021;76(1):168-190. doi: 10.1111/all.14422. DOI
3. Zhdan VM, Dvornyk VM, Lysak VP et al. Planning of effective evaluation of the activities of hospital district at the example of Poltava region. *Wiad Lek.* 2018;71(3):710-713.
4. Lyakhovs'kyy VI, Lyul'ka OM, Lyakhovs'ka TY et al. Indyvidual'ni osoblyvosti khirurhichnoyi anatomiyi lehenyvykh zv'yazok u lyudey pokhyloho viku [Individual features of surgical anatomy of pulmonary ligaments in elderly people]. *Visnyk problem biolohiyi i medytsyny.* 2016;2(129):188-190. <https://vpbm.com.ua/ua/>. [Accessed 14 November 2023] (Ukrainian)
5. Okiemy G, Foucault C, Avisse C et al. Lymphatic drainage of the diaphragmatic pleura to the peritracheobronchial lymph nodes. *Surg. Radiol. Anat.* 2003;25:32-35. doi: 10.1007/s00276-002-0081-y. DOI

6. Moon DH, Park CH, Jung JH et al. Inferior Pulmonary Ligament Division May Be Unnecessary during Left Upper Lobectomy: Effects on Lung Volume, Bronchial Angle and Bronchial Tortuosity. *J. Clin. Med.* 2021;10(18):4033. doi: 10.3390/jcm10184033. DOI
7. Seok YYi E, Cho S, Jheon S, Kim K. Perioperative outcomes of upper lobectomy according to preservation or division of the inferior pulmonary ligament. *J. Thorac. Dis.* 2015;7:2033-2040. doi: 10.3978/j.issn.2072-1439.2015.11.41. DOI
8. Kim DH, Moon DH, Kim HR et al. Effect of inferior pulmonary ligament division on residual lung volume and function after a right upper lobectomy. *Interact. Cardiovasc. Thorac. Surg.* 2019;28:760-766. doi: 10.1093/icvts/ivy344. DOI
9. Saji H, Okada M, Tsuboi M et al. Segmentectomy versus lobectomy in small-sized peripheral non-small-cell lung cancer (JCOG0802/WJOG4607L): a multicentre, open-label, phase 3, randomised, controlled, non-inferiority trial. *Lancet.* 2022;399(10335):1607-17. doi: 10.1016/S0140-6736(21)02333-3. DOI
10. Zhang Y, Fu F, Chen H. Management of Ground-Glass Opacities in the Lung Cancer Spectrum. *Ann Thorac Surg.* 2020;110(6):1796-804. doi: 10.1016/j.athoracsur.2020.04.094. DOI
11. Li G, Luo Q, Wang X et al. Inferior pulmonary ligament approach and/or interlobar fissure approach for posterior and/or lateral basal segment resection: a case-series of 31 patients. *J Thorac Dis.* 2022;14(12):4904-4915. doi: 10.21037/jtd-22-1719. DOI
12. Oshiro H, Miura M, Iobe H et al. Lymphatic Stomata in the Adult Human Pulmonary Ligament. *Lymphat Res Biol.* 2015;13(2):137-145. doi: 10.1089/lrb.2014.0009. DOI
13. Savchenko L, Mykytiuk M, Cinato M et al. IL-26 in the induced sputum is associated with the level of systemic inflammation, lung functions and body weight in COPD patients. *International Journal of COPD.* 2018;13:2569-2575. doi: 10.2147/COPD.S164833. DOI

## CONFLICT OF INTEREST

The Authors declare no conflict of interest

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