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ТОПОГРАФО-АНАТОМИЧЕСКИЕ ОСОБЕННОСТИ КЛАПАНОВ АОРТЫ И ЛЕГОЧНОГО СТВОЛА И ПЕРЕПОНЧАТОЙ ЧАСТИ МЕЖЖЕЛУДОЧКОВОЙ ПЕРЕГОРОДКИ

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TOPOGRAPHIC AND ANATOMICAL FEATURES OF THE AORTIC AND PULMONARY TRUNK VALVES AND THE MEMBRANOUS PART OF THE INTERVENTRICULAR SEPTUM

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Резюме. В статье представлены данные топографо-анатомического исследования клапанов и начальных отделов аорты, легочного ствола, а также перепончатой части межжелудочковой перегородки 30 сердец взрослого человека. Представлены морфометрические данные и установлены особенности топографии клапанов и начальных отделов аорты и легочного ствола, варианты формы и синтопии перепончатой части межжелудочковой перегородки.

Ключевые слова: сердце, человек, топография, аорта, легочный ствол, перепончатая часть межжелудочковой перегородки.

Resume. The article presents data from a topographic-anatomical study of the valves and initial sections of the aorta, pulmonary trunk, and the membranous part of the interventricular septum of 30 adult hearts. Morphometric data are presented and the features of the topography of the valves and initial sections of the aorta and pulmonary trunk, variants of the shape and syntopy of the membranous part of the interventricular septum are established.

Keywords: heart, human, topography, aorta, pulmonary trunk, membranous part of interventricular septum.

Relevance. The semilunar valves – the aortic valve and pulmonary valve – exhibit nearly symmetrical tri-leaflet configurations and are located within the outflow tracts of the left and right ventricles, facilitating blood flow into the elastic arteries [4]. The membranous part of the interventricular septum (MPIS) is a small, oval-shaped portion of the cardiac septum in adult individuals [2, 3]. The aortopulmonary septum plays a crucial role in forming of the proximal parts of aorta and pulmonary trunk, semilunar valves, outflow tracts of the heart and impacts the membranous part of the interventricular septum. Any abnormalities in the formation of the aortopulmonary septum can lead to congenital heart defects, such as persistent truncus arteriosus, interventricular defects and valves abnormality [1]. Understanding the syntopy of aortopulmonary septum derivatives is crucial for precise diagnosis and effective treatment, as their spatial relationships can influence cardiovascular function, congenital defect manifestations, and surgical approaches.

Aim: to identify morphological aspects of the aorta and pulmonary trunk, the relationship between their leaflets and their effect on the membranous part of interventricular septum.

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Objectives:

1. To present the variations of the aortic and pulmonary valves, and their relationships with each other.

2. To show the different morphological variations of the membranous part of the interventricular septum.

Material and methods. The study was conducted on 30 autopsy human adult hearts (ages 52-94) available at the Normal Anatomy Department, fixed in formalin.

The following methods were used: morphological, morphometric, statistical.

The topographic study was conducted in three major steps:

Firstly, the vessels were studied. Their thicknesses, the thickness and length of the membrane separating them, and the angle between them 2cm over the fibrous ring of each valve were measured.

Secondly, the study focused on the MPIS, where its length, width and thickness were measured. Then its various shapes were noted.

Thirdly, the relationships between the leaflets of the aortic and pulmonary valves were studied. The commissure between the right and left leaflets of the PV was fixed, and the positions of the right and left coronary leaflets of the aorta were noted in relation to it (fig. 1 A).

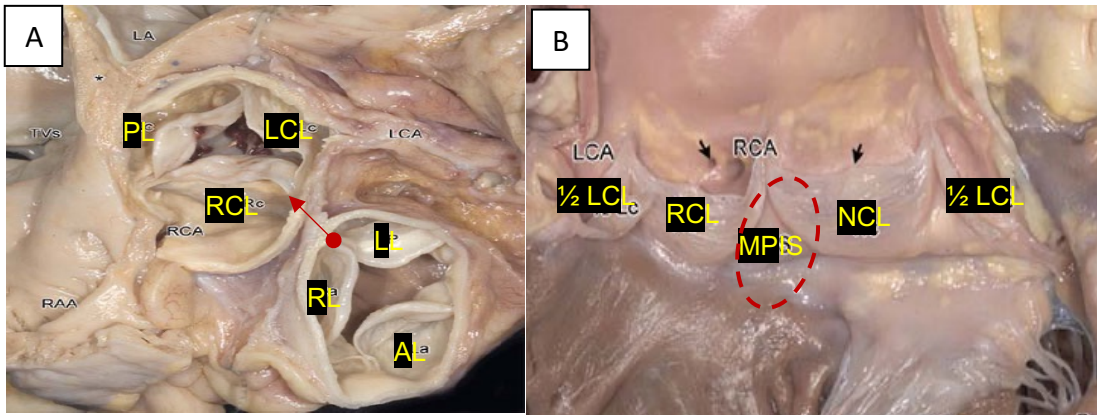

Fig. 2 – A – Superior view of aortic and pulmonary valves; B – Side view of the aorta
AL – Anterior Leaflet; RL – Right Leaflet; LL – Left Leaflet;
PL – Posterior Leaflet; RCL – Right Coronary Leaflet; LCL – Left Coronary Leaflet;
MPIS – Membranous Part of Interventricular Septum

Finally, the position of the membranous part of interventricular septum vis-à-vis the leaflets of the valves was studied and recorded (fig. 1 B).

The thickness of the arterial wall, as well as the length, width, and thickness of the membranous part of interventricular septum, contact area between the initial sections of the aorta and the pulmonary trunk, were measured. Additionally, the angle between the aorta and the pulmonary trunk was assessed. A ruler, protractor and calipers were used for measurements.

The data were analyzed using Microsoft Excel and Statistica 10.0.

Results and their discussion. *Concerning the membranous part of interventricular septum:*

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The measurements of MBIS exhibit sexual dimorphism. In females, the MBIS length is 15.00 (13.00–21.00) mm, the width is 15.00 (12.00–19.00) mm, and the thickness is 1.50 (0.80–1.70) mm. In males, the MBIS length is 16.50 (14.00–19.00) mm, the width is 14.00 (13.50–17.00) mm, and the thickness is 1.45 (1.05–1.90) mm.

A positive correlation (ρ = 0.46) was observed between MBIS length and width, indicating that as the length increases, the width also tends to increase proportionally.

Three main shapes were found– oval, rectangular, and triangular (fig. 2). The most common were the oval and triangular shapes, each being present in 31% of the cases. Second to them was the rectangular shape, showing up 24% of the time.

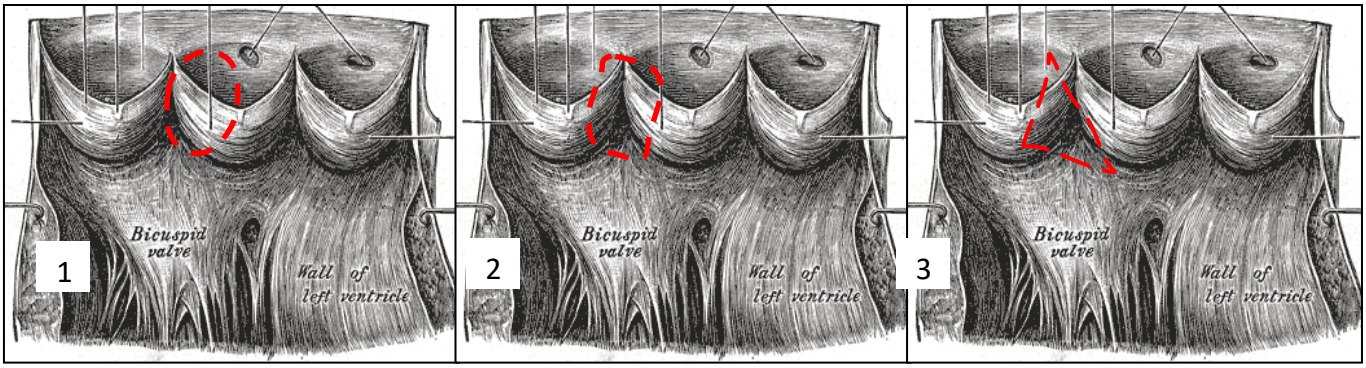

Fig. 2 – Different variants of topography of the membranous part of interventricular septum
1 – Oval Shape; 2 – Rectangular Shape; 3 – Triangular Shape

Some other shapes with much lesser frequencies were also noticed (14%). These included shapes like pentagonal or trapezoid, but they were much less recurrent than the main three shapes.

As for the position of the membranous part of interventricular septum, eight variants were recorded. The most frequent being between the right leaflet and right coronary leaflet (29%), followed by between the left leaflet and left coronary leaflet (14%), and between the commissure of the right and left leaflet, and the commissure between right and left coronary leaflets (11%). In 46% of the cases, five other positions with much lesser frequencies were recorded. The following table shows the bivariate distribution of the position concerning the aortic leaflets on one side and the pulmonary leaflets on the other side (table 1). These cases depend greatly on the relationship between the leaflets of both valves.

Tbl. 1. Different positions of the membranous part of interventricular septum

	Behind RL	Behind LL	Behind the commissure of RL and LL	Total
In front of RCL	29%	0%	7%	36%
In front of the LCL	4%	14%	11%	29%
In front of the commissure between RCL and LCL	21%	4%	11%	36%
Total	54%	18%	29%	

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Concerning the relationship between the valves:

The study found three different models of interactions between the leaflets of the aortic and pulmonary valves (fig. 3). The main interaction (50%) showed a correspondence between the commissure of the right and left one-thirds of the left coronary leaflet. The second, almost equally abundant is correspondence with the commissure between the right and left coronary leaflets (43%). A very rare case shows correspondence with the right one-thirds of the right coronary leaflet, which caused multiple variations of the position of the membranous septum.

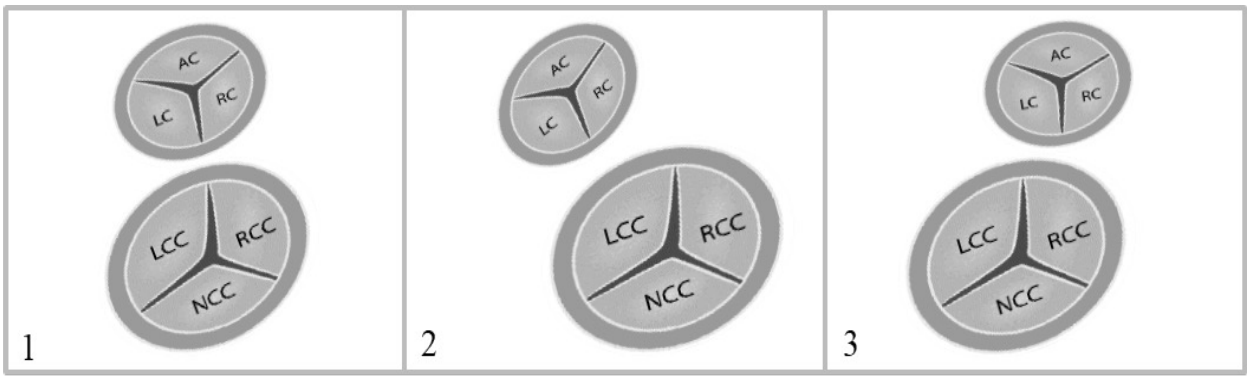

Fig. 3 – Different interactions between leaflets of Aorta and Pulmonary Trunk.
Commissure between RL and LL corresponds to: 1 – Commissure between RCL and LCL;
2 – Left 1/3 of LCL; 3 – Right 1/3 of RCL

Concerning the numerical measurements:

The measurements of the thickness of the aorta, pulmonary trunk gave the following values. The median thickness of the aortic wall is 1.80 (1.60–2.00) mm. In males, the median thickness is 1.75 (1.50–1.85) mm, whereas in females, it is 1.70 (1.40–1.80) mm. The median thickness of the pulmonary trunk wall is 0.90 (0.70–1.20) mm. In males, the median thickness is 0.95 (0.75–1.25) mm, while in females, it is 0.80 (0.70–1.00) mm.

Correlation analysis revealed a negative relationship between MBIS thickness and the thickness of both the aortic and pulmonary walls. Specifically, an inverse correlation was observed between MBIS thickness and aortic wall thickness ($\rho = -0.39$) as well as between MBIS thickness and pulmonary wall thickness ($\rho = -0.56$). This indicates that as the thickness of either the aortic or pulmonary walls increases, the thickness of the MBIS tends to decrease, and vice versa.

Anatomically, the proximal parts of aorta and pulmonary trunk are enclosed within a common sheath of visceral pericardium, which helps maintain their relative positioning. There is a contact area between the initial sections of the aorta and the pulmonary trunk. The study found that the length of contact area 3.40(2.80-3.70) cm, thickness of contact area 2.40(1.70-3.30) mm**.** According to gender, slight differences of the measurements can be noted:

For females: length of contact area 3.00(2.70-3.50) cm, and thickness of contact area 2.20(1.40-3.20) mm.

For males: length of contact area 3.35(2.70-4.05) cm, and thickness of contact area 2.00(1.35-3.45) mm.

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The angle between the aorta and pulmonary trunk measured two centimeters above the valves was approximately 32±5 degrees on average, with values going as low as 12 degrees. The study found that a minor difference is also noticed between genders: for females, angle between aorta and pulmonary trunk 28.00(25.00-35.50) degrees; for males, angle between aorta and pulmonary trunk 31.00(26.00-37.00) degrees.

Conclusion:

1. Three main shapes for the membranous septum were noted– oval (31%), triangular (31%), and rectangular (24%).

2. Eight different variations with the position of the membranous septum exist, with the most recurring being between the right leaflet and right coronary leaflet (29%).

3. Three different models of the interactions between the aortic and pulmonary valves, with the commissure between the right and left cups corresponding to the left one-thirds of the left coronary cusp being the most frequent model.

4. Sex-specific characteristics of the dimensions of the aortic wall, pulmonary trunk, and MBIS are observed.

4. MBIS length and width are positively correlated, indicating proportional growth. In contrast, MBIS thickness shows a negative correlation with both aortic and pulmonary trunk wall thickness ($\rho = -0.39$ and $\rho = -0.56$, respectively), meaning that as the thickness of these vascular walls increases, MBIS thickness tends to decrease.

5. The study revealed anatomical features in the size of the contact area and the angle 32±5 degrees between the aorta and pulmonary trunk.

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