**FGBOU VO SOGMA**

# Educational and methodological developments

For SOGMA students.

## IMAGING THE HEART AND VESSELS

A variety of techniques can be used for imaging of the heart and thoracic aorta. Each has its own merits and benefits. The method is chosen for certain clinical situations, solving specific diagnostic problems. The X-ray method, despite the new highly informative methods for obtaining medical images (ultrasound, CT, MRI), is still widely used in the study of the heart and thoracic aorta. Only the simplest, native methods (fluoroscopy, radiography) and complex, invasive contrast studies - angiocardiography, coronary angiography, aortography, retained diagnostic value.

X-ray examination acquired the greatest practical importance in the recognition of congenital and acquired heart defects.

The usefulness and reliability of diagnosis largely depends on the qualitative examination of the patient, the completeness and reliability of information about him, as well as on the ability to carry out a logical analysis and synthesis of the results obtained. At the first stage, the radiologist, studying the morphological and functional features of the patient, detects certain deviations from the normal picture (symptoms of the disease). Then he analyzes the symptoms, establishes their reliability and relationship, while highlighting the characteristic combinations of symptoms (syndromes) that reflect the pathoanatomical and pathophysiological essence of the underlying disease, which greatly facilitates the subsequent search for the correct diagnosis.

## SPECIFIC OBJECTIVES OF THE LESSON

**Know:**

1. Radiation anatomy of the heart and large vessels.
2. Methods of radiation diagnostics of the heart and main vessels: invasive and non-invasive.
   Non-invasive:
   -ultrasound methods (echocardiography, sonography, dopplerography).
   - X-ray methods: fluoroscopy, radiography.
   - CT scan.
   - Magnetic resonance imaging.
   Invasive:
   -angiocardiography, ventriculography, coronary angiography, aortography, radionuclide method (equilibrium ventriculography, radionuclide angiography, perfusion cardioscintigraphy).
3. Know the relationship between the shape and position of the heart with age, constitution and phase of respiration, standard projections for examining the heart.
4. The main symptoms and syndromes of heart damage, diagnostic programs and radiation examination schemes for them.
5. X-ray signs of various diseases of the heart and aorta.

**Be able to:**

1. Determine the method of radiation research.
2. Know the diagnostic capabilities of each method and be able to prescribe the appropriate radiological examination to the patient.
3. To know the R -anatomy of the heart and large vessels in the norm and be able to determine the pathology (identify the symptoms and syndromes of heart damage).
4. Correctly diagnose.
5. Be able to write a protocol for describing R -images.

## Base of carrying out and material equipment.

1. Study room.
2. Ultrasound room.
3. X-ray room.
4. Tables, sets of radiographs, echocardiograms, sonograms, scintigrams.

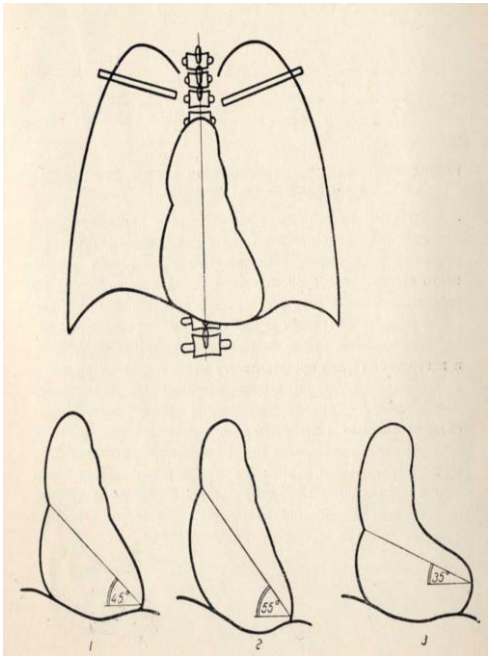
## Literature


1. V. N. Artyushkov, “Atlas and X-ray diagnostic schemes of the heart and great vessels in normal and pathological conditions”, M., 1968.
2. L. D. Lindenbraten, Methods of studying x-rays, M., 1971.
3. L. D. Lindenbraten, I. P. Korolyuk, "Medical radiology and radiology", M., 1993.
4. L. D. Lindenbraten, I. P. Korolyuk, “Medical Radiology (Fundamentals of Radiation Diagnostics and Radiation Therapy)”, M., 2000.
5. Radiation diagnostics: Textbook for universities / ed. prof. G. E. Trufanova, M., 2007.

## BLOCK OF INFORMATION

***Normal radiographic anatomy of the heart.***

The heart is located in the chest cavity with the apex to the left, down and anteriorly, and the base to the right, up and posteriorly. In this case, 2/3 of the array is to the left of the middle line and 1/3 to the right. The position largely depends on the height of the diaphragm and the constitutional type. There are three types of position of the heart according to the angle of deviation of the axis of the heart; oblique position - at 45 °; vertical position more than 45°; horizontal position less than - 45 °.




**POSITION OF THE HEART.**

*The heart is located in the chest cavity with the apex to the left, down and anteriorly, and the base - to the right, up and posteriorly. In this case , 2/3 of the array is to the left of the middle line and 73 is to the right. The position of the heart largely depends on the height of the diaphragm and the constitutional type. There are three types of position of the heart according to the angle of inclination of the axis of the heart; oblique position - 45 ° (1) ; vertical position - more than 45 ° (2); horizontal—less than 45°*

The heart looks like a homogeneous, intense darkening. The contours of the shadow of the heart protrude by 2- 3 см. to the right of the right contour of the spine. The contour of the apex on the left does not reach 2- 3 см. to the mid-clavicular line. Above, the image of the heart passes into the shadow of the mediastinum, which at this level is composed of large vessels - the aorta, the superior vena cava and the pulmonary artery.

Cardiovascular angles form between the contours of the vascular bundle and the cardiac collapse. This notch is called the waist of the heart. The angles between the contours of the heart and the diaphragm are called cardio-diaphragmatic angles.

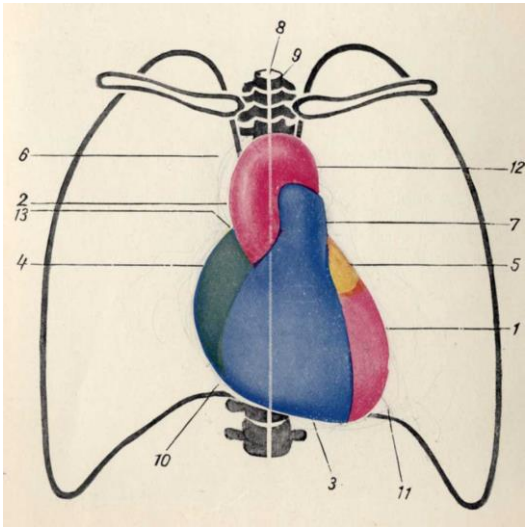
Normally, the contours of the heart are equal, clear, have the form of an arc.

***Radiation examination of the functions of the heart:***

R -scopy - evaluates contraction, relaxation of the heart, pulsation of the aorta and pulmonary artery.

Radiography of the heart - reveals the position, shape, size of the heart and great vessels, the size of the chest, the condition of the lungs, diaphragm.

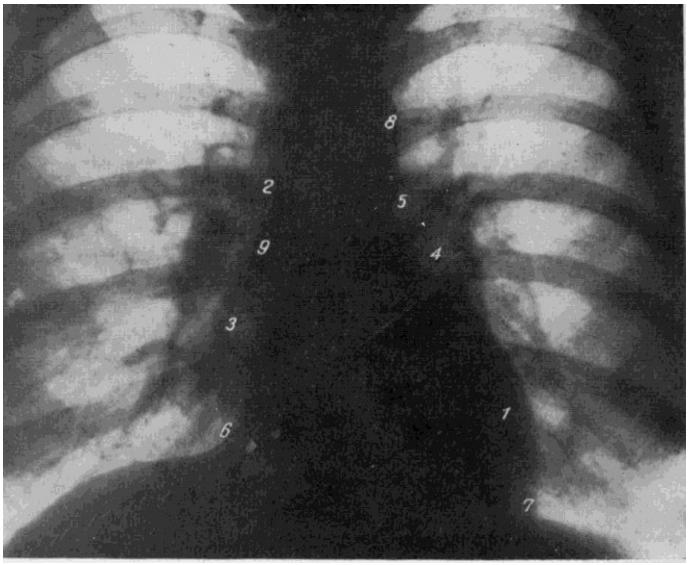
Spend 4 standard projections : front, I (right) oblique, II (left) oblique and Λ lateral.




## HEART V PROJECTION SCHEME FORWARD POSITION

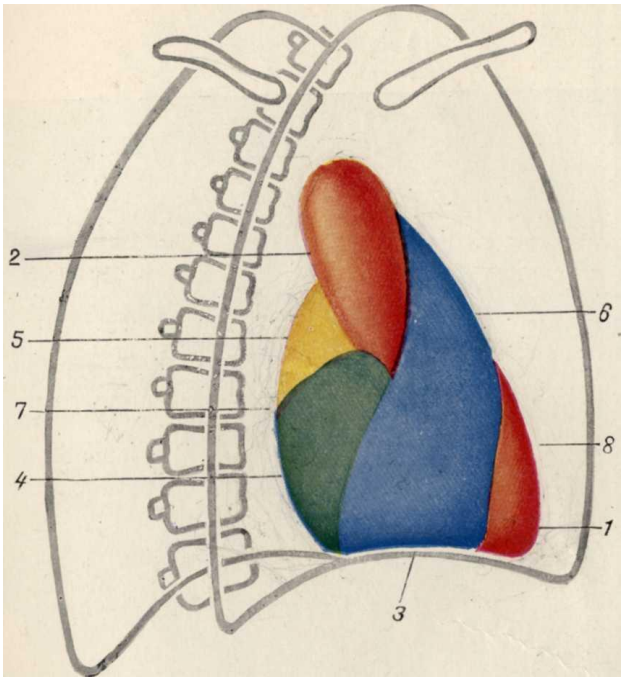
*1 - the contour of the left ventricle;* 2 *— a contour of the ascending aorta;* 3 *- right ventricle;* 4 *— a contour of the right auricle;* 5 *— a contour of an ear of the left auricle;* in *- the contour of the upper hollow yen;* 7 *- pulmonary artery;* 8 *- median line:* 9 *- spine;* 10 *- right cardio-diaphragmatic angle;* 11 *- left cardio-diaphragmatic angle;* 12 *- aortic arch;* 13 *- right atriovasal angle.*

*In the x-ray image, the shape of the heart is determined by the configuration of its individual cavities and great vessels.*




## *RADIOGRAPH OF NORMAL CHEST IN FORWARD POSITION .*

1 *- arc of the left ventricle;* 2 *— an arch of the ascending aorta;* 3 *— an arch of the right auricle;* 4 *— an arch of an ear of the left auricle;* 5 *— an arch of a pulmonary artery;* 6 *- right cardio-diaphragmatic angle;* 7 *- left cardio-diaphragmatic angle;* 8 *- aortic arch;* 9 *— the right atriopolyty corner.*

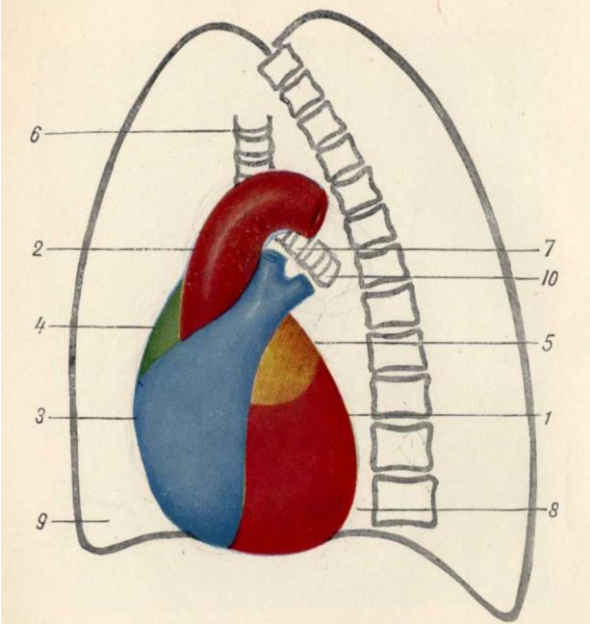



***HEART PROJECTION SCHEME IN THE FIRST OBLIQUE POSITION (right shoulder turn to the screen by 45°).***

*1 — a contour of a left ventricle; 2 - contour of the aorta; 3 - right ventricle; 4 — a contour of the right auricle; 5 — a contour of the left auricle; 6 — a contour of an arterial cone; 7 - retrocardial space; 8 - retrosternal space.*


***RADIOGRAPH OF THE NORMAL CHEST IN THE FIRST OBLIQUE POSITION.***

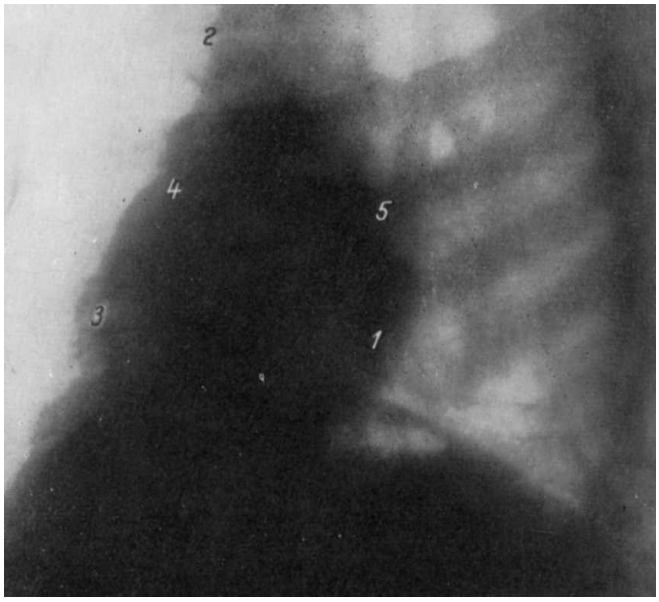
*1 - arc of the left ventricle;* 2 *- aorta;* 3 *— an arch of the right auricle;* 4 *— an arch of the left auricle;* 5 *— an arch of an arterial cone.*




***SCHEME OF PROJECTION OF THE HEART IN THE SECOND OBLIQUE POSITION (turn the left shoulder to the screen by 50-60°).***

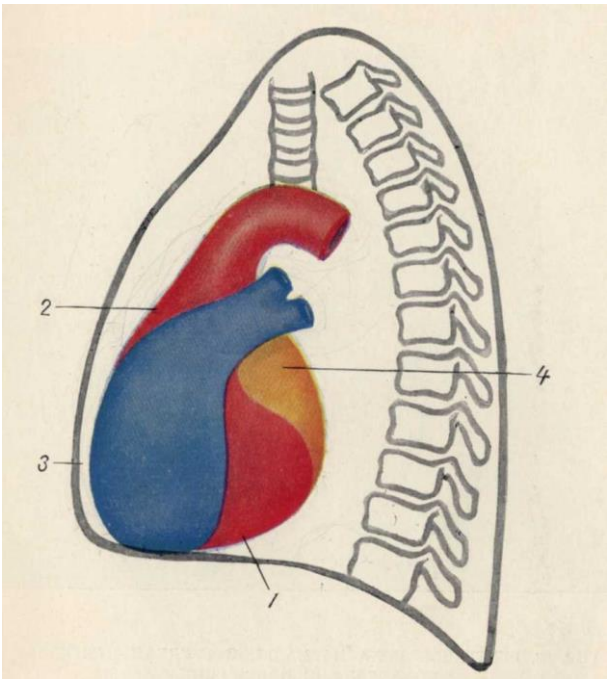
*1 - the contour of the left ventricle; 2 - contour of the aorta; 3 - the contour of the right ventricle; 4 — a contour of the right auricle; 5 — a contour of the left auricle;*

*6 - trachea; 7 - bifurcation of the trachea; 8 - retrocardial space; 9 - retrosternal space; 10 - left bronchus.*



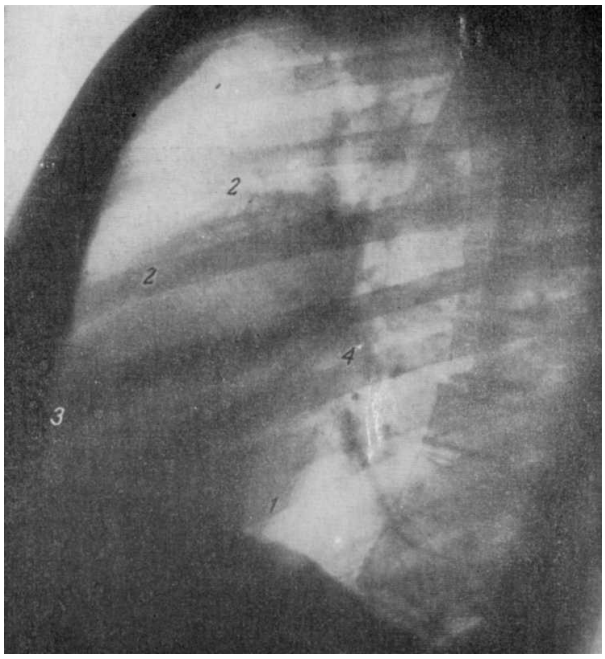

**RADIOGRAPH OF THE NORMAL CHEST IN THE SECOND OBLIQUE POSITION.**

1 - arc of the left ventricle; 2 - ascending part of the aorta; 3 — an arch of a right ventricle; 4 — an arch of the right auricle; 5 — an arch of the left auricle.




**HEART PROJECTION SCHEME IN THE LEFT LATERAL POSITION.**

*1 - the contour of the left ventricle; 2 — a contour of the ascending aorta; 3 - the contour of the right ventricle; 4 — a contour of the left auricle.*




**RADIOGRAPH OF THE NORMAL CHEST IN THE LEFT LATERAL POSITION.**

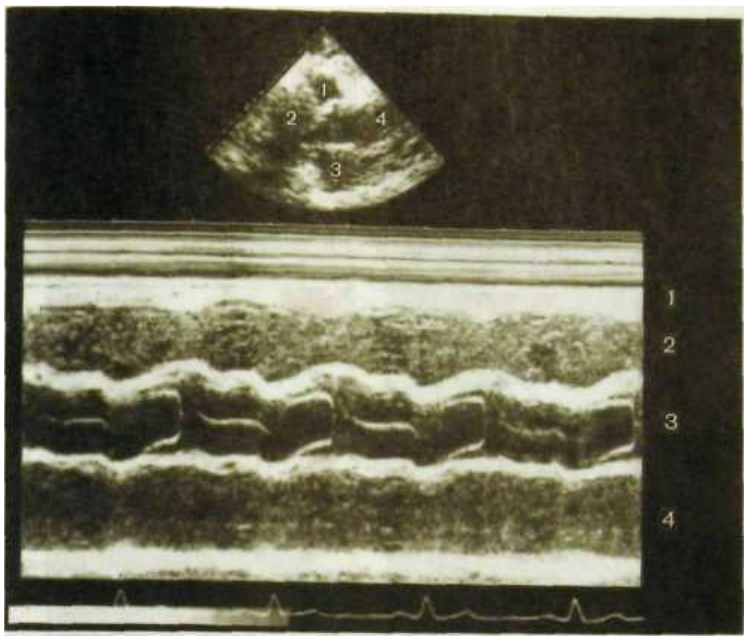
*1 - arc of the left ventricle; 2 — an arch of an initial part of an aorta; 3 — an arch of a right ventricle; 4 — an arch of the left auricle.*

**Ultrasound** 1) one-dimensional technique - echocardiography,
2) two-dimensional technique - sonography,
3) before plerography.

Echocardiography has the form of curves, each of which corresponds to a specific structure of the heart. The amplitude indicates the range of systolic movements of the anatomical structure.

Sonography makes it possible to observe the movements of the walls of the heart and valves in real time on the monitor screen.

Dopplerography is carried out in a pulsed mode, they study the movements of the valves and walls of the heart in any phase of the cardiac cycle and measure the speed of blood movement, the direction and nature of its flow.




**ultrasonic study hearts And aorta .**

*Up — sectoral sonogram : 1 - right ventricle , 2 — left ventricle ,*

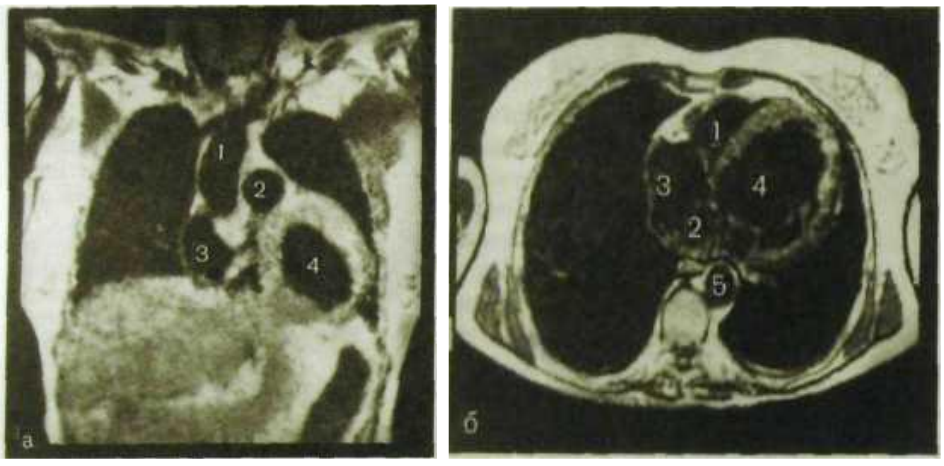
*3 — aorta , 4 — left atrium ;*

*at the bottom — M - echocardiogram : 1 - anterior wall hearts 2 - _ right ventricle ,*

*3 - aorta And aortic valve , 4 — left atrium .*

***Magnetic resonance imaging*** . To obtain a high-quality image, it is carried out synchronized with the contractions of the heart and with the phases of respiration.

The technique allows you to study the contractility of the heart and valve function. Modern models of MR tomographs make it possible to perform multi-phase MRI cinema simultaneously at several anatomical levels. It is possible to observe the passage of a contrast agent through the chambers of the heart, the distribution of the first pain in CV in the myocardium, which makes it possible to assess its perfusion in real time.



**Magnetic resonance _ tomograms hearts And main vessels :**

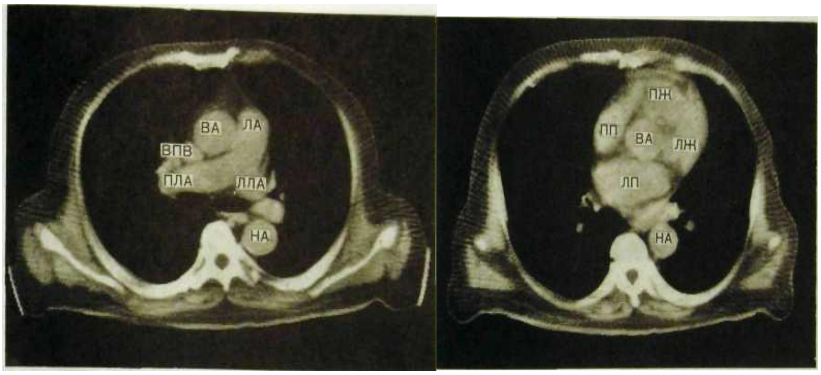
*but — straight projection : 1 - ascending aorta , 2 — pulmonary artery 3 - right atrium , 4 - left ventricle ; 6 - axial projection : I - right ventricle , 2 — left atrium , 3 — right atrium , 4 - left ventricle , 5 - descending aorta .*

MRI provides a differentiated image of the walls of the heart and the blood in its cavity.

Normally, the myocardium on MRI scans gives an isointense signal (gray), the pericardium is hypointense (black signal), adipose tissue gives the most intense signal and is displayed in white. A clear image is received by the myocardium, heart valves, muscles, pericardium. MRI can detect cicatricial lesions of the myocardium, thrombi of the heart and aorta, stenosis and insufficiency of the aortic valve, differentiate exudate and transudate with accumulations of blood in the pericardial cavity.

***Computed tomography*** of the heart and thoracic aorta is performed in natural contrast (native CT) or using artificial blood contrast (CT angiocardiography).

Native CT - the study gives a general idea of the organs of the chest. At the same time, the external outlines of the chambers of the heart, limited by fatty layers, the ascending and descending parts of the thoracic aorta in axial sections, and the aortic arch in the longitudinal are visible.




**Computer tomograms hearts from amplification ( slices fulfilled on the various levels hearts ).**

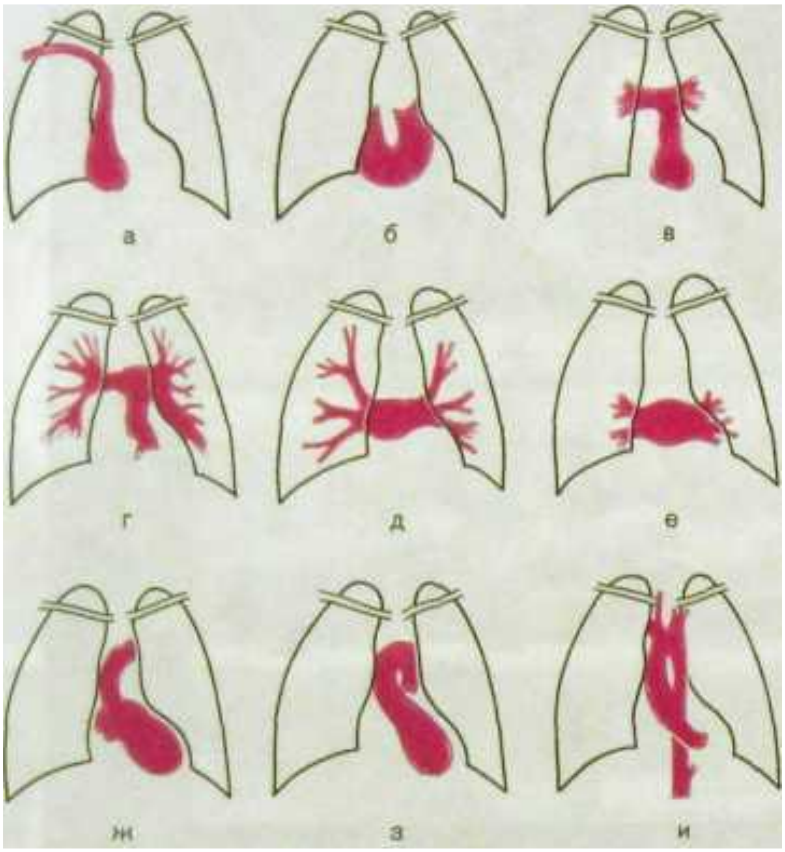
*ERW — upper hollow vein ; VA — ascending aorta ; LA — pulmonary artery ;*
*PLA — right branch pulmonary arteries ; LLA — left branch pulmonary arteries ;*
*ON THE — descending aorta ; pancreas — right ventricle ; LV — left ventricle ;*
*PP — right atrium ; LP — left atrium .*

CT angiocardiography has much greater potential in assessing the condition of the heart, coronary arteries, and aorta. This technique is based on an artificial increase in the density of blood in the chambers of the heart and in the vessels, which provides a separate image of their cavities and walls.

***Special radiopaque techniques.***

***Angiocardiography*** **-** artificial contrasting of the heart cavities, diagnosis of complex concomitant heart defects. Examines the position, shape, size of the cavities of the heart; the sequence of their filling with the RCM, changes in the intensity and uniformity of their contrasting, the rate of passage of the RCM, the state of the valvular apparatus; measure intracardiac pressure; blood gas composition, cardiac output and stroke volume.

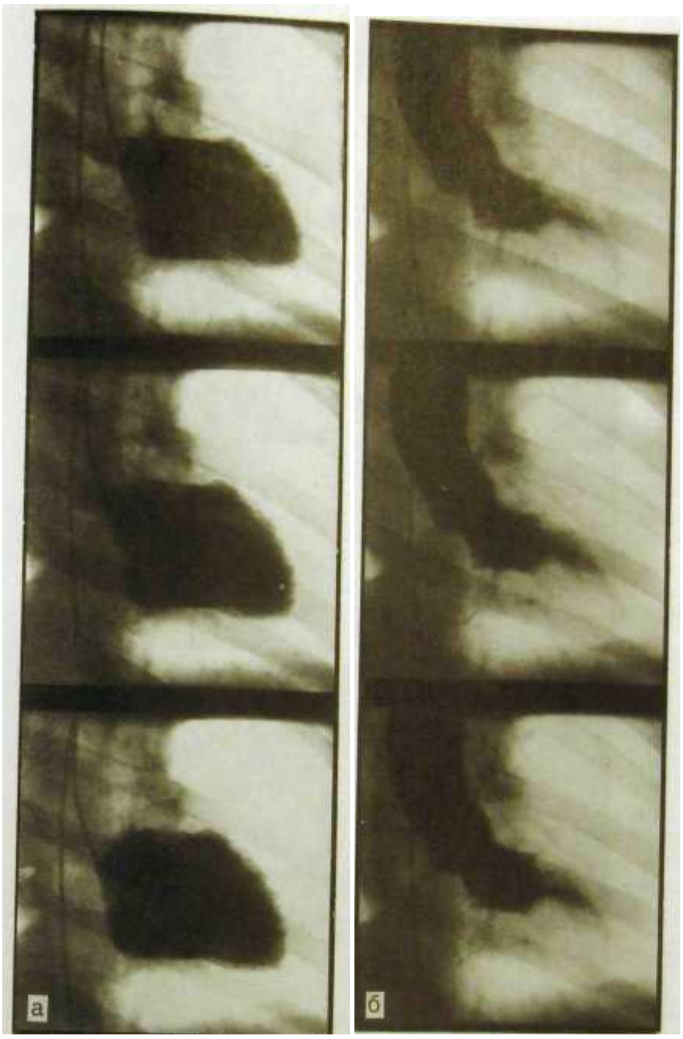
***Aortography*** (contrast X-ray examination of the thoracic aorta) is highly informative in the diagnosis of aneurysms, occlusions, and anomalies of the thoracic aorta. However, unlike ultrasound, CT, MRI, it gives an idea only about the lumen of the aorta and does not allow to judge the state of the heart vessel.




*The sequence of filling the cavities of the heart and vessels with a contrast agent during angiocardiography*

*but — through l s after introductions drug in ulnar vein ; b—and — images received _ across every subsequent give me a sec research .*

***Coronary angiography*** is a contrast study of the coronary arteries of the heart to accurately determine the nature, degree, localization of vascular damage and assess collateral blood flow.




**Left ventriculography . Contrasting substance fills cavity left ventricle hearts .**

*but — phase diastole ; b — phase systole*

***Radionuclide method*** : used to characterize the morphological and functional changes in the heart.

*basic techniques* :

- perfusion myocardial scintigraphy,
- scintigraphy of the focus of myocardial infarction,
- radionuclide equilibrium ventriculography,

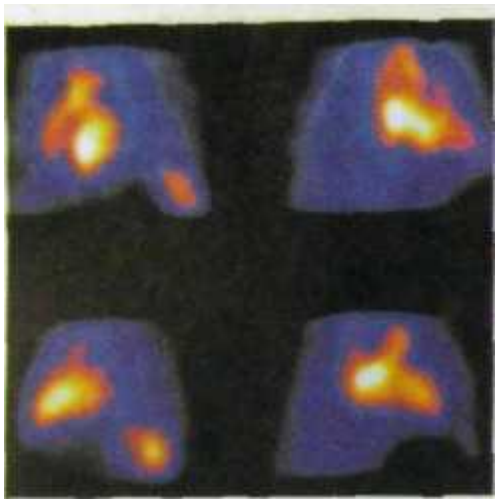
Myocardial perfusion scintigraphy is based on the use of radiopharmaceuticals that selectively accumulate in intact cardiac muscle tissue in proportion to the intensity of coronary blood flow. Normally, a uniform intensive accumulation of the drug in the myocardium of the left ventricle is determined.

In areas of the myocardium with reduced blood flow, the accumulation of radiopharmaceuticals is reduced, and in necrotic, scarred areas, it is completely absent (negative scintigraphy).

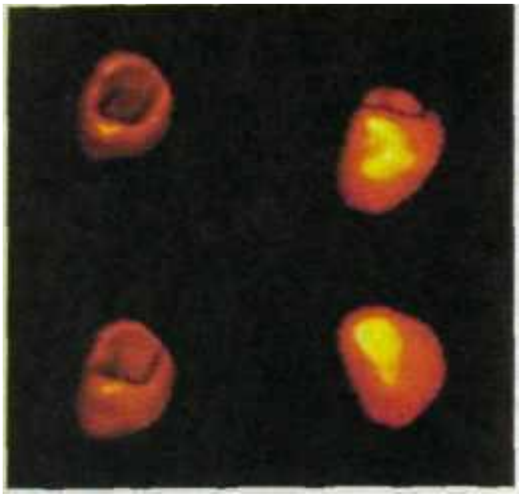
Diffuse myocardial perfusion disorders are characterized by uneven inclusion of radiopharmaceuticals over the entire image area.

*Scintigraphy of the* focus of myocardial infarction is based on the use of radiopharmaceuticals that are tropic to the damaged myocardium (positive scintigraphy).

Reliable local inclusion of the radionuclide in the lesion occurs no earlier than 10 hours from the appearance of the first clinical signs of infarction and remains at a sufficient level for 5-6 hours.



Scintigraphy hearts
at circulation RFP in blood
equal weight ventriculogram



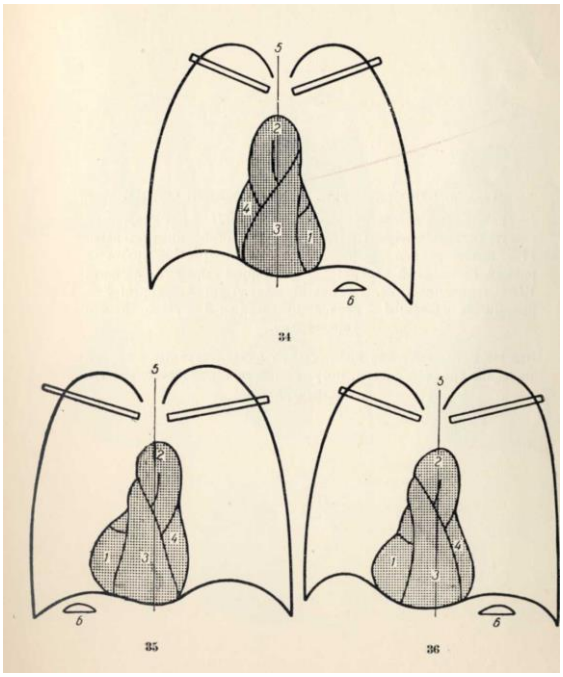
Volumetric reconstruction
hearts at radionuclide research _

*Radionuclide* equilibrium ventriculography (REVG) is performed using the method of labeling erythrocytes and in vivo . After a dense dilution of the radiopharmaceutical in the blood, the γ-camera records several hundred images, on the basis of which a single averaged image of the cardiac cycle, the contractile function of the heart over several cardiac cycles, visualization of the heart image in various phases is formed. The main indications for RVG are ischemic heart disease, myocardial infarction, cardiac aneurysm, hypertension, diffuse lesions of the heart muscle.

**Radiation symptoms and syndromes of heart damage.**

1. ***Change in the position of the heart:***

-dextrapposition - right-sided position of the heart;
- dystopia - the heart through the defect of the sternum goes outside the chest;
-ectopia - the descent of the heart is delayed in the embryonic period and cervical, thoracic, abdominal (if the heart descends into the abdominal cavity through a defect in the abdominal cavity) forms of ectopia.
-dextrocardia - all chambers are located in a mirror image in relation to the norm;
- in pathological conditions, the heart is displaced with effusion pleurisy, diaphragmatic hernia, tumors.
- tugging of the heart is observed with wrinkling processes in the lung tissue.




## *CHANGES IN THE POSITION OF THE HEART.*

*1 - left ventricle; 2 - aorta; 3 - right ventricle; 4 - right atrium;*

*5 - median line; 6 - gas bubble of the stomach.*

*Congenital mesocardia - the median location of the heart; is extremely rare.*

## *CHANGES IN THE POSITION OF THE HEART.*

*1 - left ventricle; 2 - aorta; 3 - right ventricle; 4 - right atrium;*

*5 - median line; 6 - gas bubble of the stomach.*

*Congenital dextrocardia with complete reversal of internal organs.*

## *CHANGES IN THE POSITION OF THE HEART .*

*1 - left ventricle; 2 - aorta; 3 - right ventricle; 4 - right atrium;*

*5 - median line; 6 - gas bubble of the stomach.*

*Congenital dextrocardia with the reverse location of the heart only.*

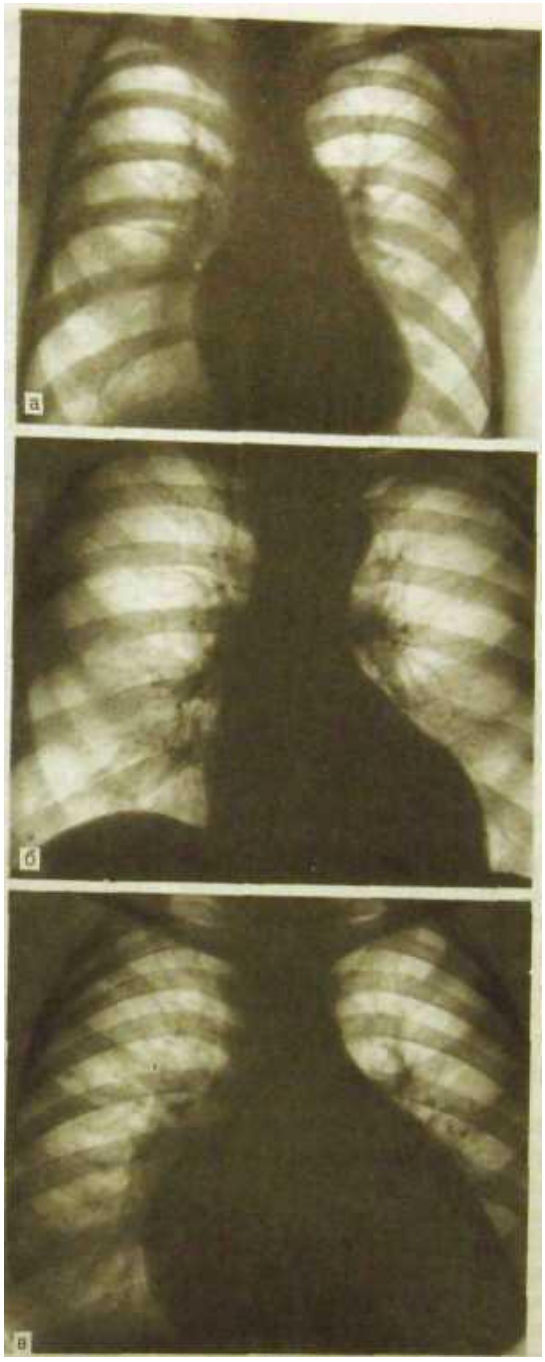
2. ***The change in the shape of the heart*** depends on the position of the body, the level of standing of the diaphragm.

With a pathology of the shape of the heart:

- mitral : the waist disappears, the II and III arches on the left lengthen and protrude more than usual into the left lung field. Higher than normal is the right cardiovascular angle;
- aortic: the waist of the heart is pronounced, between the I and IV arcs of the left contour there is a deep retraction of the contour. The right cardiovascular angle is displaced to the bottom. The arches corresponding to the aorta and the left ventricle are elongated and more convex.

Normally , a form close to the mitral occurs in young women; aortic - in elderly people with a hypersthenic constitution.

## The form shadows hearts on the radiographs in straight projections



*but — mitral ; b — aortic ; in — trapezoidal ( triangular ).*

***3. Change in the size of the heart.***

- General enlargement of the heart as a result of pericardial effusion, dilation of all chambers of the heart (congestive cardiomyopathy).
- Enlargement of individual chambers of the heart (elongation and more convex character of the arcs).

***4. Change in heart contractions.***

- The frequency of pulsation of the vessels, the depth of contractions, rhythm, the speed of movement of the walls of the heart at the time of contraction. There are additional contractions and relaxations, a change in the thickness of the wall of the heart.

**Radiation picture of heart damage**

***Ischemic heart disease*** is associated with a violation of coronary blood flow and a decrease in myocardial contractility in ischemic areas.

Ultrasound scanning: uneven contraction of various sections of the wall of the left ventricle,

- in the ischemia zone - a decrease in the amplitude of movement during systole,
- decrease in systolic thickening of the myocardium,
- the ejection fraction of the left ventricle is reduced with increased contraction of the right ventricle (further, the ejection fraction of the right ventricle also decreases).

Myocardial perfusion scintigraphy:

- areas of ischemia are areas of reduced fixation of radiopharmaceuticals,
- if previously registered accumulations of radiopharmaceuticals persist, this is a persistent loss of blood circulation (a scar in the myocardium).

CT - in the ischemic zone there is a low density and a delay in the contrast peak (a contrast agent is injected intravenously). The systolic thickening of the myocardium decreases, the mobility of the internal contour of the ventricular wall is reduced.

Coronary angiography - vasoconstriction, irregularity of its contours, tortuosity of vessels, amputation of vessels in their thrombosis, the presence of marginal defects.

**Coronarogram at atherosclerosis**

*constriction branches left coronary arteries ( specified arrow ).*

***Myocardial infarction.***

Radiography:

- an increase in the shadow of the heart. In 1-2 weeks after a heart attack, the size of the heart decreases by 25%.

Ultrasound: - zones of general and local violation of contractility of the left ventricle, its expansion;

- hypokinesia in the area of circulatory disorders;
- hyperkinesia of intact adjacent areas.

RNM: Perfusion myocardial scintigraphy - complete absence of radiopharmaceutical accumulation in the necrotic area of the myocardium (negative scintigraphy).

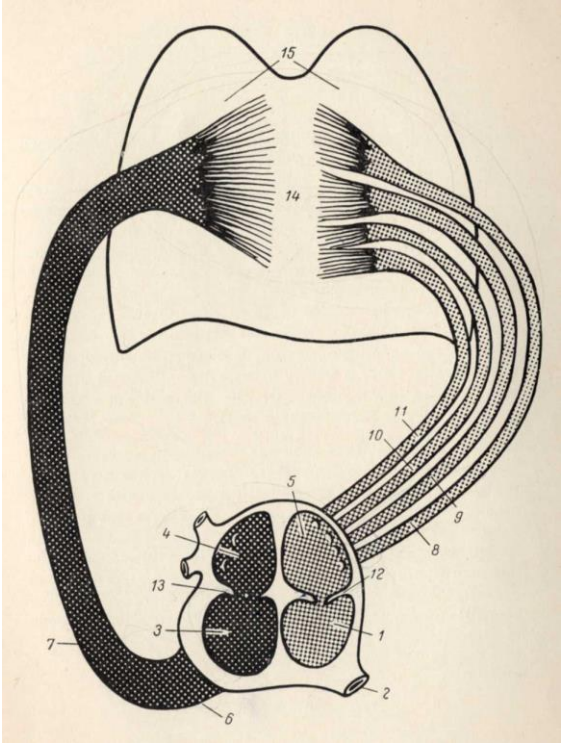
Scintigraphy of the focus of myocardial infarction - the area of hyperfication of the radiopharmaceutical (positive scintigraphy).

Radionuclide equilibrium ventriculography, echocardiography: area of left ventricular wall akinesia; decrease in the ejection fraction of the left ventricle.

***Mitral defects.***

*Mitral valve insufficiency.*

Complete closure of the valve leaflets during systole does not occur. This leads to the throwing of blood into the left atrium, overflowing with blood, increasing pressure. Pulmonary veins are full-blooded, venous plethora of lungs develops. Right ventricular overload and myocardial hypertrophy. The left ventricle expands.




**SCHEME OF HEMODYNAMIC DISTURBANCE IN STENOSIS OF THE LEFT VENOUS HOLE.**

*1 - left ventricle; 2 - aorta (hypoplastic); 3 — a right ventricle (is sharply increased); 4 - right atrium; 5 - left atrium (moderately enlarged); 6 - arterial cone (appears); 7 — pulmonary arteries (with the increased diameter); 8-11 - pulmonary veins (with a reduced diameter); 12 - bicuspid valve; 13 - tricuspid valve; 14 - the second pulmonary barrier; 15 - light.*

*Explanation of the mechanism of hemodynamic disturbances. IN the moment of systole of the left atrium as a result of the existing obstacle in the form of a narrowed opening, the blood does not completely pass into the left ventricle and venous congestion occurs in the atrium. This stagnation captures retrograde and pulmonary veins, gradually increasing passive intravenous pressure. At the same time, intra-atrial pressure rises, causing irritation receptors located at the mouths of the confluence of the veins, at the points of branching of the pulmonary artery up to the capillaries. This leads, on the one hand, to the occurrence of a spasm of small branches of the pulmonary artery system, on the other hand, to an increase in the pressure of the venous capillaries. Osmotic pressure reaches critical levels, which in turn causes hypertonicity of the venous capillary network. This creates a second pulmonary barrier. This barrier impedes the work of the right ventricle, its hypertrophy and dilatation occurs.*

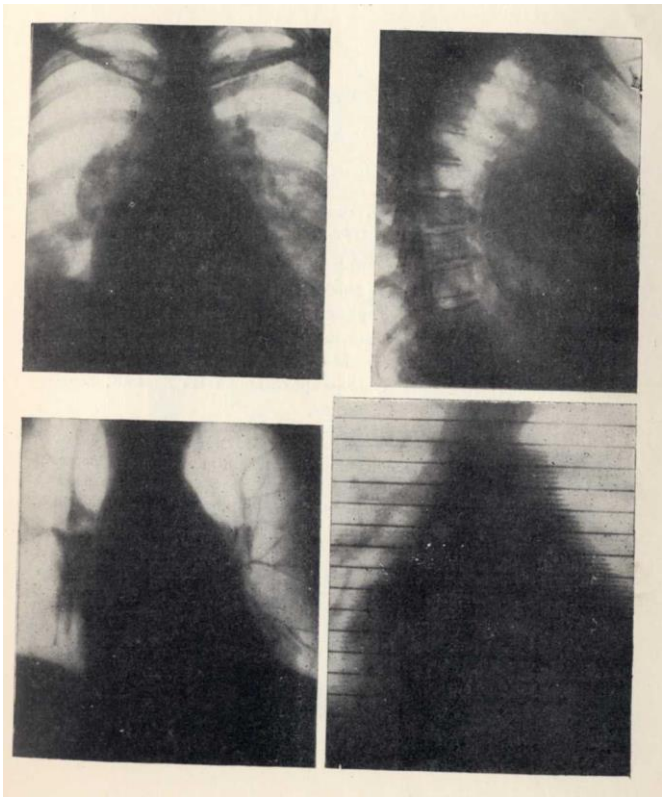
*Depending on the myogenic factor and the reactions of the vessels of the pulmonary circulation, stenosis can occur in five variants of cardiac congestion in the lungs according to I. Kh. Rabkin.*

Radiography:

- Mitral shaped heart
- the right cardiovascular angle is higher than normal,
- II and III arcs on the left protrude into the pulmonary field due to the expansion of the pulmonary cone and the trunk of the pulmonary artery,
- IV arch is elongated and approaches the median clavicular line,
- with severe valve insufficiency, the expansion of the pulmonary veins is determined - venous plethora,
- in oblique images, an increase in the right ventricle and left atrium (pushing back the esophagus a along an arc of a large radius).

Ultrasound: - expansion of the left atrium and left ventricle,
- the amplitude of the opening of the mitral valve increases; eddy movements of blood are recorded above the valves,
- the walls of the left ventricle are thickened, contractions are strengthened,
- in systole, the reverse flow of blood into the left atrium is determined.

DEHOCG: - Regenerative blood flow through the mitral valve from the left ventricle to the left atrium.

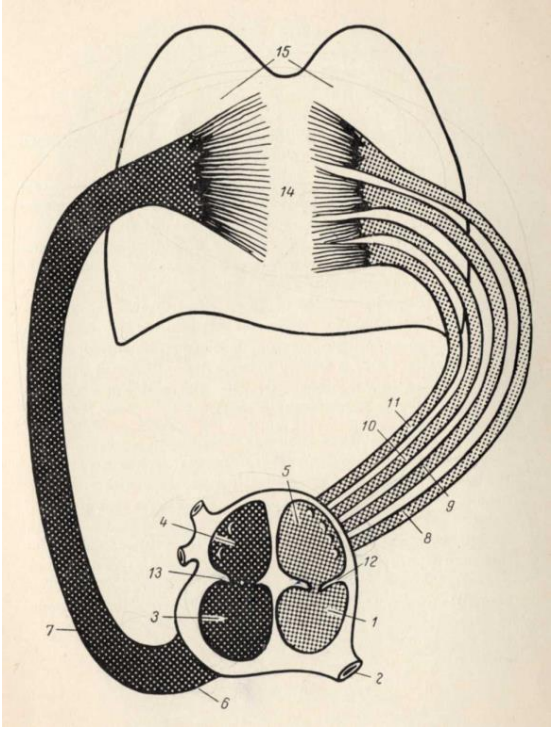


**RADIOGRAPHS OF A PATIENT WITH SEVERE BIOVALVE INSUFFICIENCY.**

*In a direct projection, a typical mitral configuration: an increase in the heart in both directions; phase of pulmonary hypertension: the roots are expanded, especially on the right, in the form of a large node. In the first oblique projection, the contrasted esophagus is pushed aside along a large radius arc. The tomogram shows an aneurysmal expansion of the mouth of the confluence of the right upper pulmonary vein, passing into the dilated left atrium (contrast-free cardiography). On the roentgenogram, a sign of ventricularization of the teeth of the left atrial appendage is revealed.*

*Mitral valve stenosis* :

Obstructed blood flow from the left atrium to the left ventricle. The left atrium is dilated, the emptying of the pulmonary veins is difficult (venous congestion in the lungs). The caliber of the pulmonary veins and the expansion of the trunk increase, the pressure rises. If D is greater than 60 мм. rt. Art. there is a spasm of the pulmonary artery and small branches of the pulmonary artery and then an overload of the right ventricle.

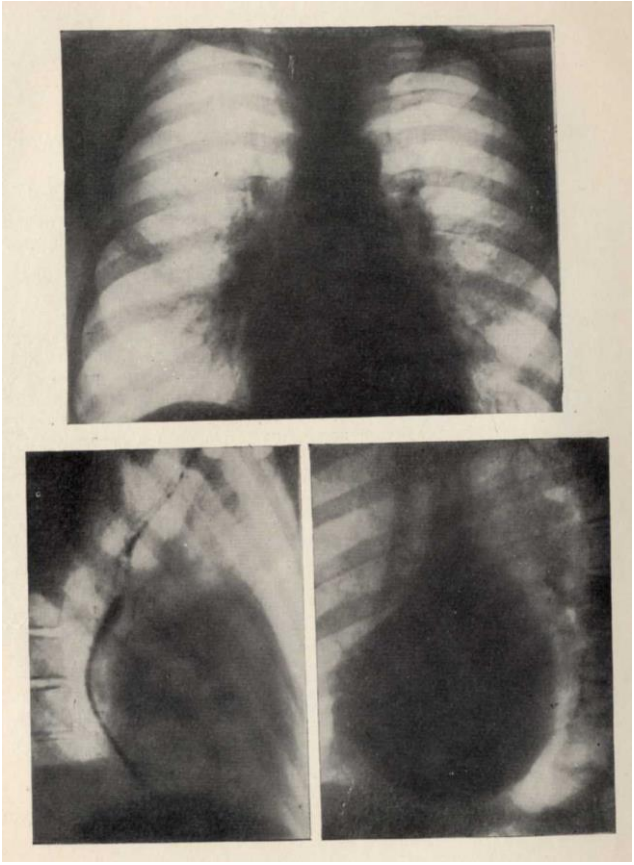



**SCHEME OF HEMODYNAMIC DISTURBANCE IN STENOSIS OF THE LEFT VENOUS HOLE.**

*1 - left ventricle; 2 - aorta (hypoplastic); 3 — a right ventricle (is sharply increased); 4 - right atrium; 5 - left atrium (moderately enlarged); 6 - arterial cone (appears); 7 — pulmonary arteries (with the increased diameter); 8-11 - pulmonary veins (with a reduced diameter); 12 - bicuspid valve; 13 - tricuspid valve; 14 - the second pulmonary barrier; 15 - light.*

*Explanation of the mechanism of hemodynamic disturbances. IN the moment of systole of the left atrium as a result of the existing obstacle in the form of a narrowed opening, the blood does not completely pass into the left ventricle and venous congestion occurs in the atrium. This stagnation captures retrograde and pulmonary veins, gradually increasing passive intravenous pressure. At the same time, intra-atrial pressure rises, causing irritation receptors located at the mouths of the confluence of the veins, at the points of branching of the pulmonary artery up to the capillaries. This leads, on the one hand, to the occurrence of a spasm of small branches of the pulmonary artery system, on the other hand, to an increase in the pressure of the venous capillaries. Osmotic pressure reaches critical levels, which in turn causes hypertonicity of the venous capillary network. This creates a second pulmonary barrier. This barrier impedes the work of the right ventricle, its hypertrophy and dilatation occurs .*

Depending on the myogenic factor and the reactions of the vessels of the pulmonary circulation, stenosis can occur in five variants of cardiac congestion in the lungs according to I. Kh. Rabkin.



**RADIOGRAPHS OF A PATIENT WITH MITRAL STENOSIS.**

*Severe arterial hypertension; deviation of the esophagus when it is contrasted along an arc of small radius (first oblique position) and a significant increase in the right ventricle (first - second oblique position).*

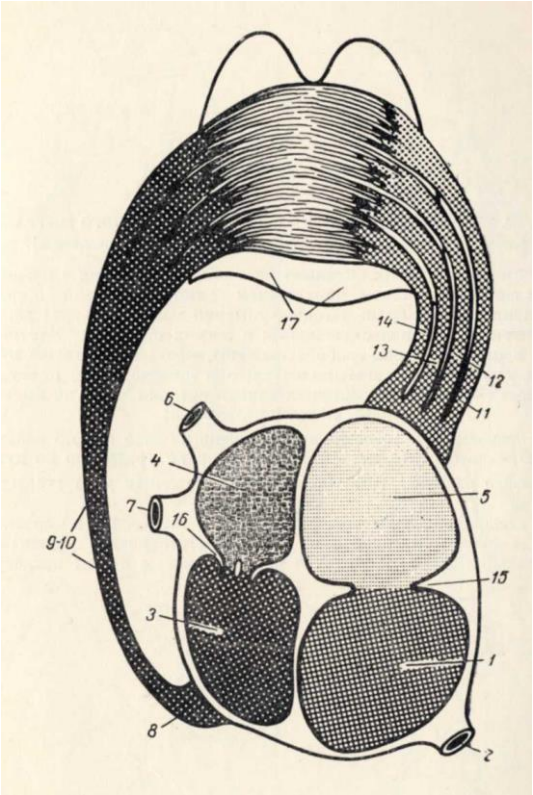
Radiography:

- the mitral form of the heart differs from insufficiency: the waist is not only flattened, but even bulges due to an increase in the trunk of the pulmonary artery and protrusion of the left auricle of the left atrium . The IV arc of the left circuit is not lengthened, since the left ventricle is not enlarged and contains less blood than normal.
- expansion of the right ventricle and left atrium,
- the esophagus is displaced along an arc of a small radius,
- the roots of the lungs are expanded due to the branches of the pulmonary artery,
- in the n / outer parts of the lung fields, narrow thin strips (L. Kerley) due to lymphostasis.

Ultrasound: - the left atrium is dilated,

- the leaflets of the mitral valve are thickened, the image is layered,
- decrease in the area of the mitral orifice,
- calcification of the mitral valve leaflets.

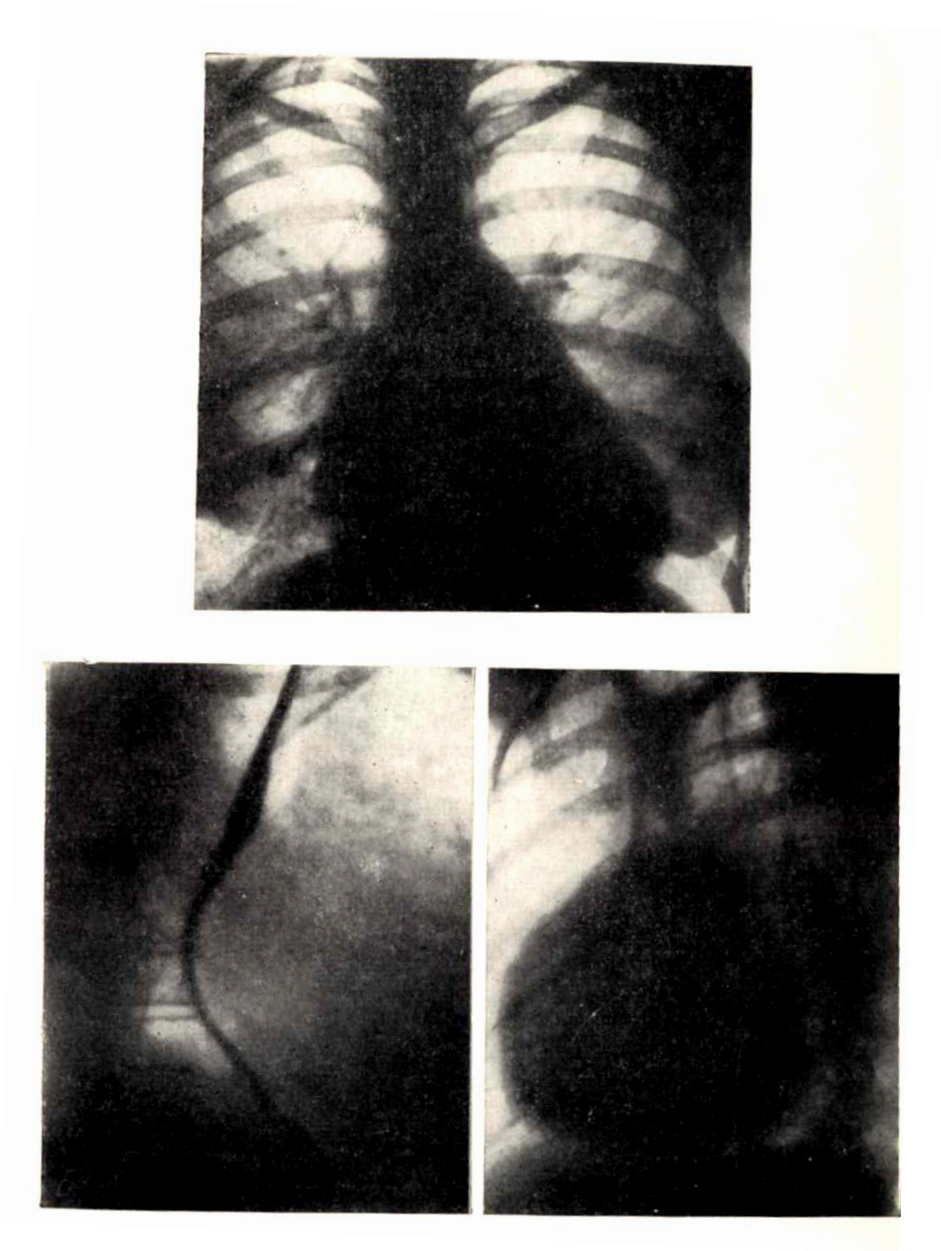
DEHOCG: an increase in the maximum velocity of the transmitral blood flow, an increase in the diastolic pressure gradient between the left atrium and the left ventricle.




## SCHEME OF HEMODYNAMIC DISTURBANCE IN COMBINED MITRAL DEFECT.

*1 - left ventricle (enlarged); 2 - aorta; 3 - right ventricle (enlarged); 4 - right atrium; 5 - left atrium (expanded); 6 - superior vena cava; 7 - inferior vena cava; 8 - arterial cone; 9, 10 - right and left branches of the pulmonary artery; 11-14 - pulmonary veins; 15 - remains of a bicuspid valve; 16 - tricuspid valve; 17 - light.*

*Explanation of the mechanism of hemodynamic disturbances. This type of defect is much more common than isolated stenosis and insufficiency. The prevailing defect also gives a more pronounced manifestation of its radiological signs. The question of the prevalence of orifice stenosis or valve insufficiency is decided in conjunction with the data of other, modern research methods. In addition to regurgitation of blood from the left ventricle into the left atrium due to incomplete closure of the valves, there is incomplete emptying of the left atrium into the ventricle due to stenosis of the orifice.*



**RADIOGRAMS OF A PATIENT WITH COMBINED MITRAL DISEASE.**

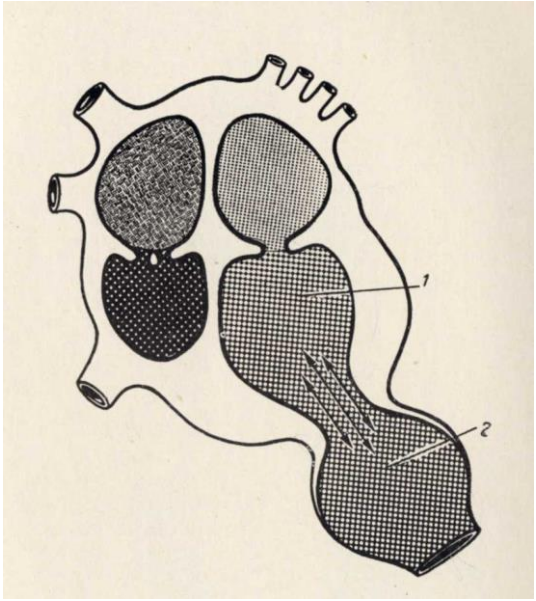
*On the anterior radiograph, a significant expansion of the heart in diameter with a pronounced mitral configuration. The right root is wide and conically branched. On the right in the basal-lateral section - Kerley's lines. In the first oblique position, the contrasted esophagus is pushed back along a large radius arc. In the second oblique position, an increase in both ventricles and the left atrium.*

***Aortic defects***

*Deficiency* :

The doors are not sealed. In diastole, part of the blood from the aorta returns to its cavity, there is an overload of the left ventricle. The aorta expands in the ascending part as a result of increased blood ejection and hypertrophy of the left ventricular myocardium occurs.

X-ray: deep and fast contractions of the left ventricle, sweeping, pulsation of the ascending aorta.

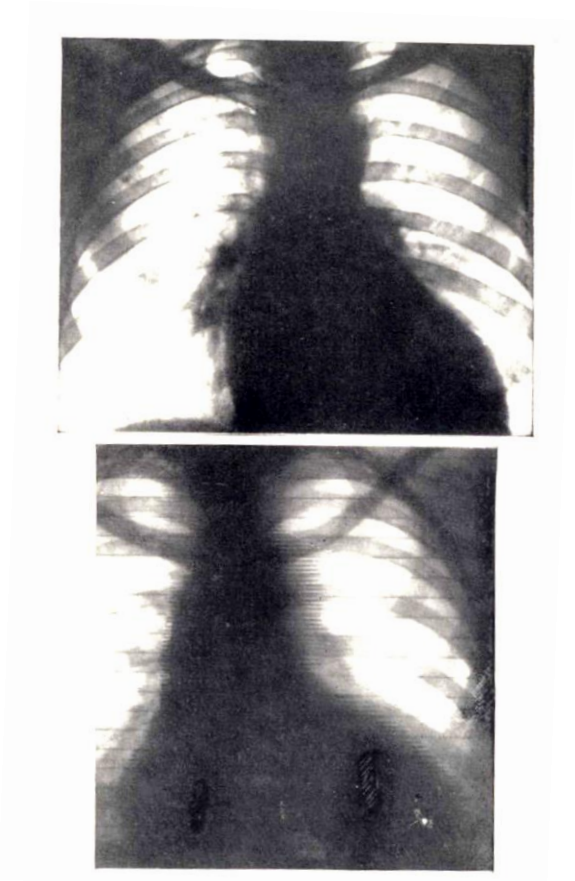



**SCHEME OF HEMODYNAMIC DISTURBANCE IN AORTIC VALVES INSUFFICIENCY.**

*1 - left ventricle (significantly dilated and hypertrophied); 2 - aorta (evenly expanded).*

*Explanation of the mechanism of hemodynamic disturbances. During diastole of the left ventricle, its cavity is filled not only with blood coming from the left atrium, but also to a large extent with blood returning from the aorta through a defect in the semilunar valves. As a result, the cavity of the left ventricle overflows with blood, its primary dilatation occurs, and the increased stroke volume of blood with severe hypersystole is ejected into the aorta. In this regard, the initial part of the aorta and its arch expand sharply and immediately collapse as a result of the reverse flow of blood into the left ventricle. A sudden increase in blood pressure with a rapid fall in it creates a pronounced pulsation of the aorta. Before the appearance of relative insufficiency of the mitral valve with this defect, the main changes are observed in the left ventricle and aorta. With the advent of relative insufficiency of the mitral valve, "mitralization" of the aortic defect occurs with a change in the pulsations characteristic of aortic insufficiency.*

Radiography: - aortic heart shape. The waist, as a result of the lengthening and convexity of the aortic arch and the left ventricle, is noticeably deepened and emphasized.



**RADIOGRAPHS OF A PATIENT WITH AORTIC VALVES INSUFFICIENCY** .

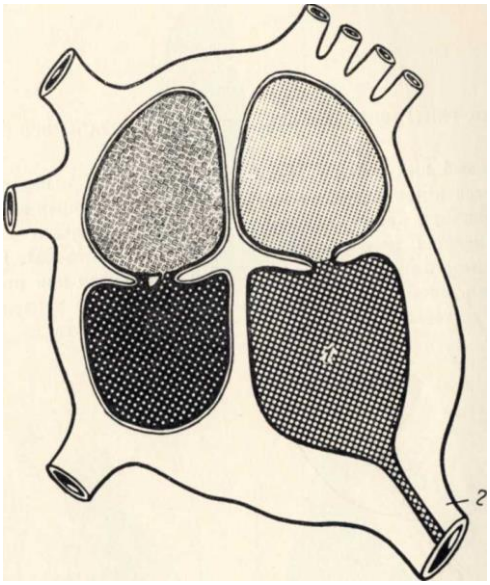
*Typical aortic configuration of the heart. Local enlargement of the left ventricle. Expansion of the aorta. On the roentgenogram - excited pulsation along the arc of the left ventricle. On the aorta - the teeth in amplitude significantly exceed the ventricular ones.*

Ultrasound: - expansion of the cavity of the left ventricle.
- increased pressure in the supravalvular aorta,
- increase in the amplitude and speed of movement of the wall of the left ventricle.
- myocardial hypertrophy.

DECHOKB and X-ray contrast aortography: visualization of regurgitant blood flow from the aorta to the left ventricle.

*Aortic stenosis* :

The left ventricle is not completely emptied during the systole phase, an additional volume of blood appears in it, as a result of which it expands.



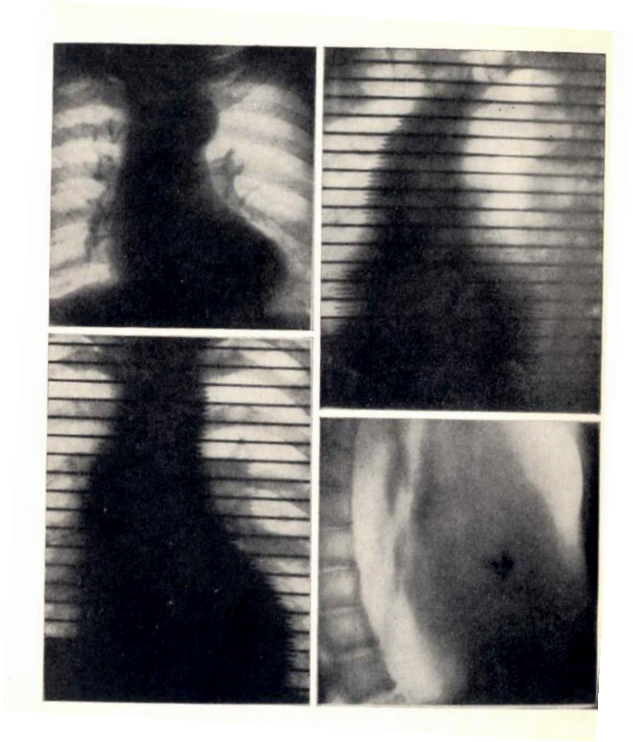

**SCHEME OF HEMODYNAMIC DISTURBANCE IN AORTIC STENOSIS.**

*1 - left ventricle (hypertrophied); 2 — an aorta (with the expressed narrowing of an opening).*

*Explanation of the mechanism of hemodynamic disorders. At the time of left ventricular systole, with narrowing of the aortic orifice, there are obstacles to the passage of blood from the left ventricle to the aorta. Blood under high pressure in a narrow stream passes into the aorta, meeting on its way the wall of the initial part of the ascending aorta. Although the time of expulsion of blood from the ventricle to the aorta is lengthened, however, not all blood is completely ejected from the left ventricle, and the systemic circulation as a result is partially impoverished. During diastole, the left ventricle receives blood from the left atrium, which, with the remaining blood, enlarges the cavity of the left ventricle (tonogenic dilatation), and subsequent hypersystoles lead to muscle hypertrophy. Thus, with this defect, the left ventricle and systemic circulation are most affected* **.**

Radiography:

- aortic heart shape: the arch of the left ventricle is rounded and shifted to the left,
- expansion of the ascending part of the aorta, since a strong stream of blood rushes through the narrowed opening of the aortic valve in it, so the aortic arch protrudes more than normal into the pulmonary field,
- downward displacement of the right cardiovasal angle.



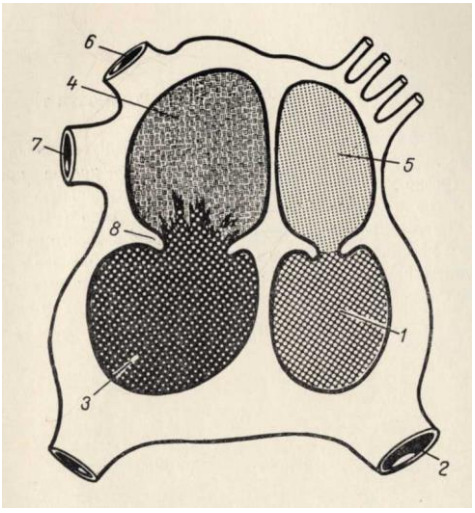
***RADIOGRAMS OF A PATIENT WITH AORTIC STENOSIS***

*Typical aortic configuration. Enlargement of the left ventricle to the left and posteriorly. The ascending aorta is dilated, and on X-ray kymograms there are large teeth in this section. Along the aortic arch, the teeth are reduced. On the tomogram - calcification in the area of the aortic valves.*

X-ray: slow, tense movement of the walls of the left ventricle.

Ultrasound: left ventricular enlargement, myocardial hypertrophy, decrease in systolic divergence of aortic valve cusps ; thickening, compaction, calcification of the aortic valve; reduction in the area of the aortic ostium.

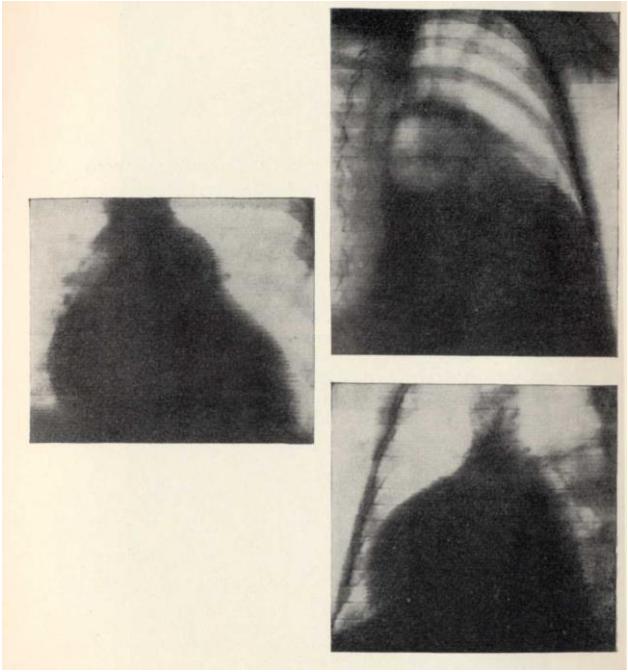
DEHOCT: an increase in the maximum aortic blood flow velocity, an increase in the systolic pressure gradient across the aortic valve.




***SCHEME OF HEMODYNAMIC DISTURBANCE IN THIS TRICUSULAR VALVE INSUFFICIENCY.***

*1 - left ventricle; 2 - aorta; 3 - right ventricle (di-lyated, its wall is hypertrophied); 4 - right atrium (sharply dilated); 5 - left atrium; 6 - superior vena cava (expanded); 7 - inferior vena cava (expanded); 8 - tricuspid valve with severe insufficiency when closing.*

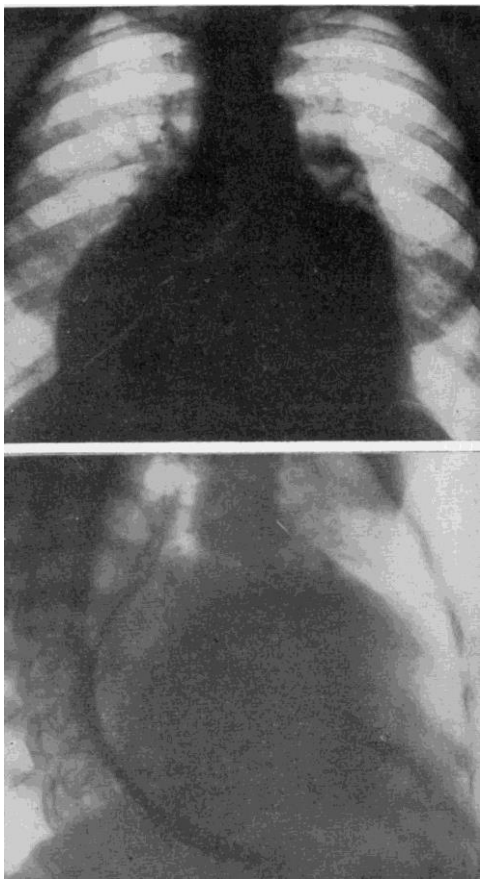
*Explanation of the mechanism of hemodynamic disturbances. Tricuspid valve insufficiency can be organic and functional in nature. Very often complicates mitral stenosis. At the time of the systole of the right ventricle, blood from it enters not only the pulmonary artery, but also into the cavity of the right atrium, which, similarly to the left one, expands in case of insufficiency of the bicuspid valve, after which the increased volume of blood from the right atrium enters the right ventricle. This creates hypertrophy and dilation of the right atrium and right ventricle. With the loss of tone of the heart muscle, stagnation appears in the system of hollow veins.*



**RADIOGRAPHS OF A PATIENT WITH SECONDARY TRAICULID VALVE INSUFFICIENCY (with mitral stenosis).**

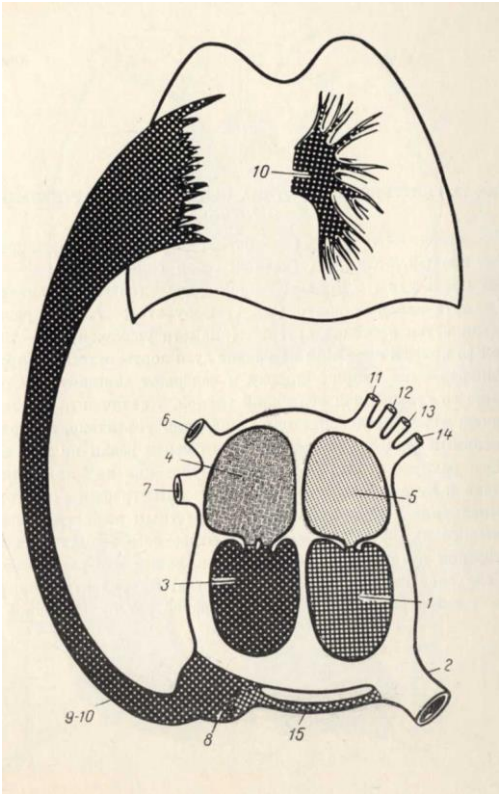
*In the direct projection - the mitral configuration of the heart. The right border of the heart is significantly shifted to the right. In the first oblique projection - filling of the retrocardial space not only in the upper section (due to the left atrium), but also below (right atrium). In the second oblique projection, in addition to an increase in the left atrium and right ventricle, there is a change in the anterior cardiovascular angle (instead of obtuse it is almost straight).*

*X-ray diagnostics is based on a significant displacement of the border of the heart to the right, the execution of the retrocardial space in the lower section in the first oblique projection and the reduction of the cardiovascular angle to a straight line in front in the second oblique projection.*



**RADIOGRAPHS OF A PATIENT WITH STENOSE OF THE RIGHT VENOUS.**

*In isolated form, it is quite rare, often combined with damage to the mitral and aortic valves. X-ray diagnostics is very difficult. On the presented radiographs in three typical projections, venous congestion in the lungs is revealed. A sharp increase in the size of the heart, especially to the right. On the radiograph in the first oblique projection with a contrasted esophagus, the latter is noticeably pushed back along an arc of large radius (by the left atrium). In the lower part of the retrocardial space, the shadow of the heart extends beyond the contrasted esophagus (enlargement of the right atrium) - mitral valve insufficiency, stenosis of the right venous opening*

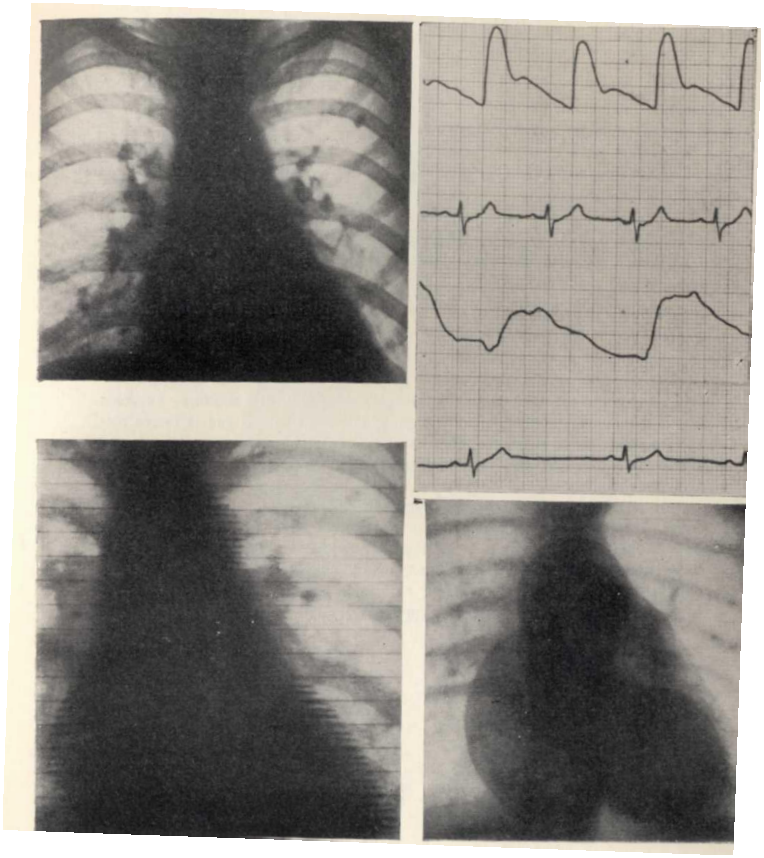



## SCHEME OF HEMODYNAMIC DISTURBANCE IN OPEN ARTERIAL DUCT.

*1 - left ventricle (enlarged); 2 - aorta (enlarged); 3 - right ventricle (may be enlarged); 4 - right atrium; 5 - left atrium (slightly enlarged); 6 - superior vena cava; 7 - inferior vena cava; 8 - arterial cone; 9,10 - pulmonary arteries (dilated); 11-14 - pulmonary veins (moderately dilated); 15 - unclosed botallian duct.*

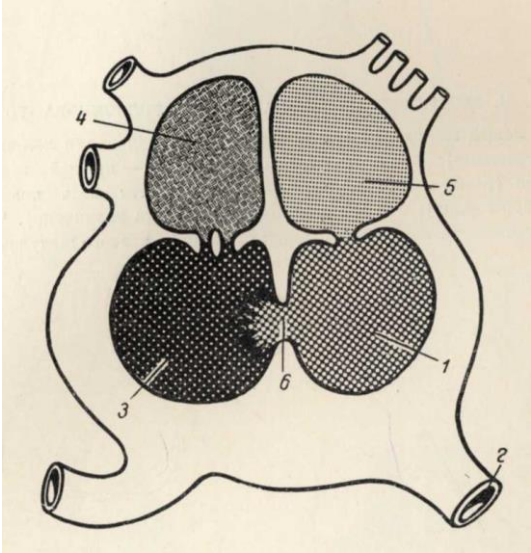
*Explanation of the mechanism of hemodynamic disturbances. As a result of a significant predominance of pressure in the aorta compared to pressure in the pulmonary artery, part of the blood from the aorta through the ductus arteriosus enters the pulmonary artery (sometimes into its left branch); at the same moment, the right ventricle also ejects blood from its cavity into the pulmonary artery. The vessels of the lung overflow with blood; at the same time, part of the blood coming from the lungs returns to the lungs again, bypassing the systemic circulation. The aorta gradually expands. An additional amount of blood, discharged through the ductus arteriosus, is driven through the left chambers of the heart, while the right chambers receive less of a certain amount of blood due to the depletion of the systemic circulation. To maintain the desired blood pressure in a large circle, the left ventricle does a lot of work, due to which it hypertrophies, and since it also pumps a larger amount of blood against the norm, it expands. If at first the pulmonary artery and its branches react to an increase in blood volume by expanding the lumen without increasing pressure (hypervolemia), then with the age of the patient or with a significant reset, to prevent pulmonary edema and excessive overflow of the left heart, spasm of the pulmonary arterioles occurs, which leads to pulmonary hypertension. It increases the load on the right ventricle and causes it to enlarge.*

*Thus, with an open arterial duct, an increase in the left parts of the heart (larger than the left ventricle) and hypervolemia of the pulmonary circulation first occur. With the development of pulmonary hypertension there is an increase in the right heart. The pulsation of the left ventricle and aorta is increased.*



**RADIOGRAMS OF A PATIENT WITH AN OPEN ARTERIAL DUCT.**

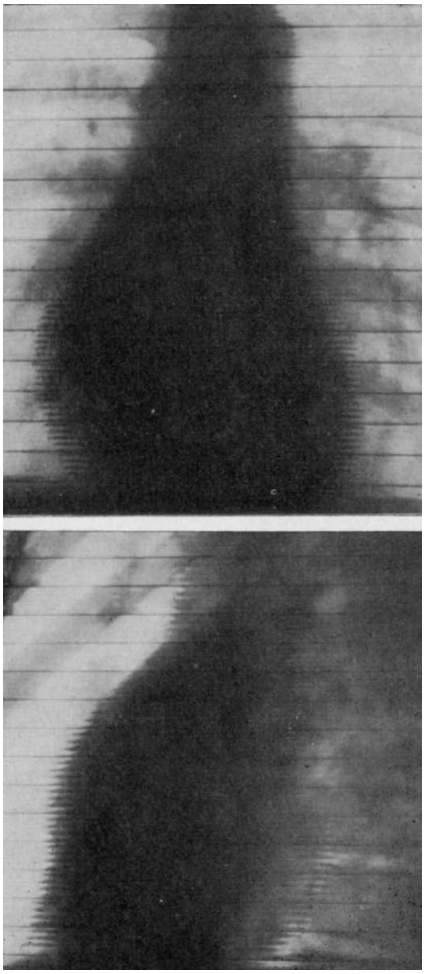
*Hyperwave. The roots are dilated but structural, containing so-called cherries (tangential section of dilated arteries). The left ventricle is enlarged, the left atrium is moderately enlarged. Expanded aorta. An x-ray kymogram showed increased pulsation along the arch of the left ventricle and aorta. On the internal angiocardiogram, the right chambers are not contrasted. Contrast agent in the left ventricle and aorta. Repeated contrasting of the pulmonary artery. Electrokymography: on the curve of the main trunk of the pulmonary artery - a steep rise, a pointed apex and a low-lying prong of the semilunar valves slamming. On the curve from the right branch of the pulmonary artery, a "shunt" wave (additional rise in the curve in protodiastole ).*




**SCHEME OF HEMODYNAMIC DISTURBANCE IN VENTRICULAR SEPTAL DEFECT (TOLOCHINOV'S DISEASE—ROGER).**

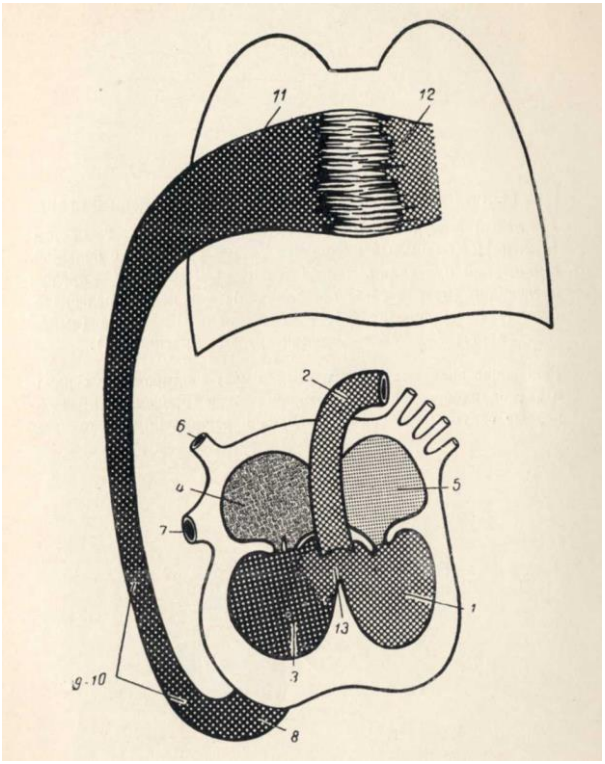
*1 - left ventricle; 2 - aorta; 3 - right ventricle (enlarged);*
*4 - right atrium; 5 - left atrium; 6 — defect of an interventricular partition.*

*Explanation of the mechanism of hemodynamic disturbances. At the time of systole, blood is shunted from the left ventricle to the right (due to higher pressure in the cavity of the left ventricle). The right ventricle and pulmonary artery system overflow with blood and dilate. Pulmonary hypertension develops with rather large septal defects and causes right ventricular hypertrophy. The pressure in it rises and the direction of the discharge of blood may change. In this condition, the left ventricle also hypertrophies. Thus, with this defect, the right ventricle suffers, the vessels of the pulmonary circulation, and in the event of pulmonary hypertension, the left ventricle.*



**RADIO-KIMOGRAMS OF A PATIENT WITH TOLOCHINOV'S DISEASE - ROGER.**

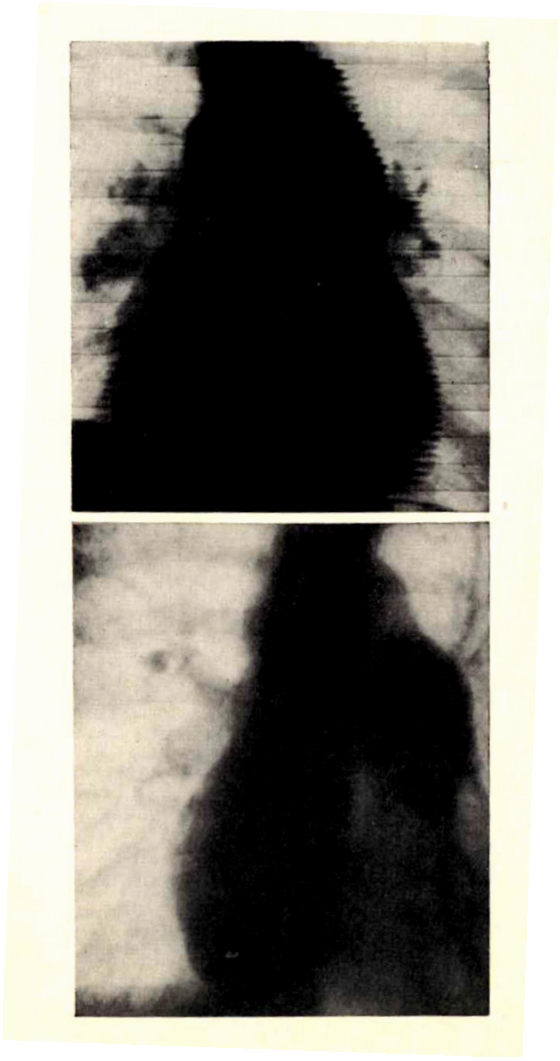
*Hypervolemia. Middle position of the heart. The waist is flattened. Enlarged right ventricle; on the right contour of the heart, ventricular teeth over a large extent. Their amplitude exceeds that of the teeth of the left ventricle. In the second oblique projection, a moderate increase in the left atrium is additionally noted.*




**SCHEME OF HEMODYNAMIC DISTURBANCE IN EISENMENGER'S COMPLEX.**

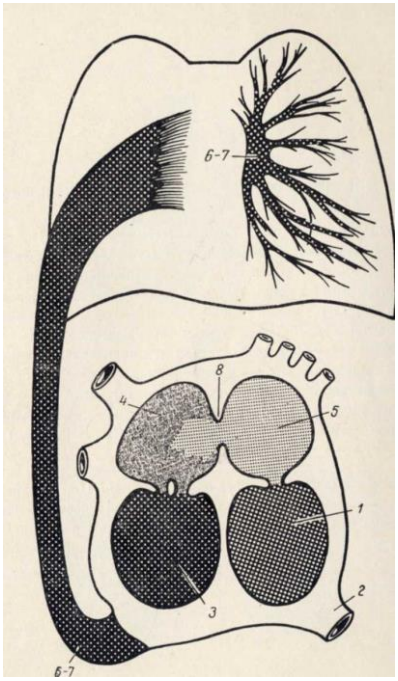
1 - *left ventricle (not changed, but may be enlarged); 2 - aorta ("mounted" on the interventricular septum, narrower in diameter than the pulmonary artery);* 3 - *right ventricle (enlarged and hypertrophied);* 4 - *right atrium (slightly enlarged);* 5 - *left atrium (not changed, but may be enlarged);* 6.7 - *vena cava;* 8 - *arterial cone (swells);* 9, 10 - *pulmonary arteries (dilated);* 11 — *small branchings of a pulmonary artery (enriched with blood);* 12 — *small veins (enriched with blood);* 13 — *high defect of an interventricular partition.*

*Explanation of the mechanism of hemodynamic disturbances. Due to a high-lying and significant defect in the membranous part of the interventricular septum, hemodynamics is impaired to a greater extent than with a defect in the muscular part of the septum. At the time of left ventricular systole, large amounts of blood enter the right ventricle and pulmonary artery. The latter expand and hypertrophy. With this defect, pulmonary hypertension occurs much more often and earlier, in which there may be a discharge of blood to the left with clinical cyanosis. As a rule, both atria also increase.*



**RADIOGRAPHS OF A PATIENT WITH EISENMENGER'S COMPLEX.**

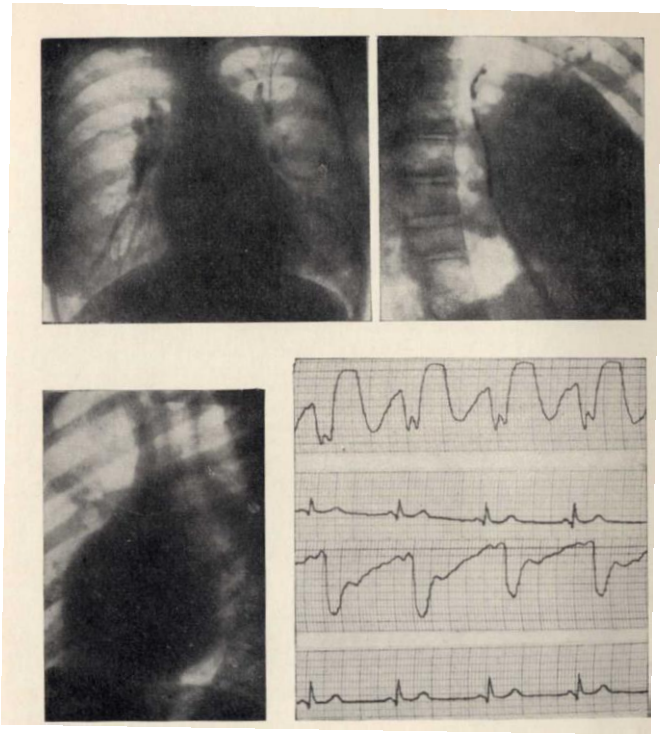
*The radiograph clearly shows a significant increase in the right border of the heart due to the right ventricle; enrichment of the roots, bulging of the second cardiac arch on the left. On the internal angiogram, simultaneous contrasting of the cavities of the right heart and aorta.*




**SCHEME OF HEMODYNAMIC DISTURBANCE IN THE DEFECT OF THE INTERATRIAL SEPTER.**

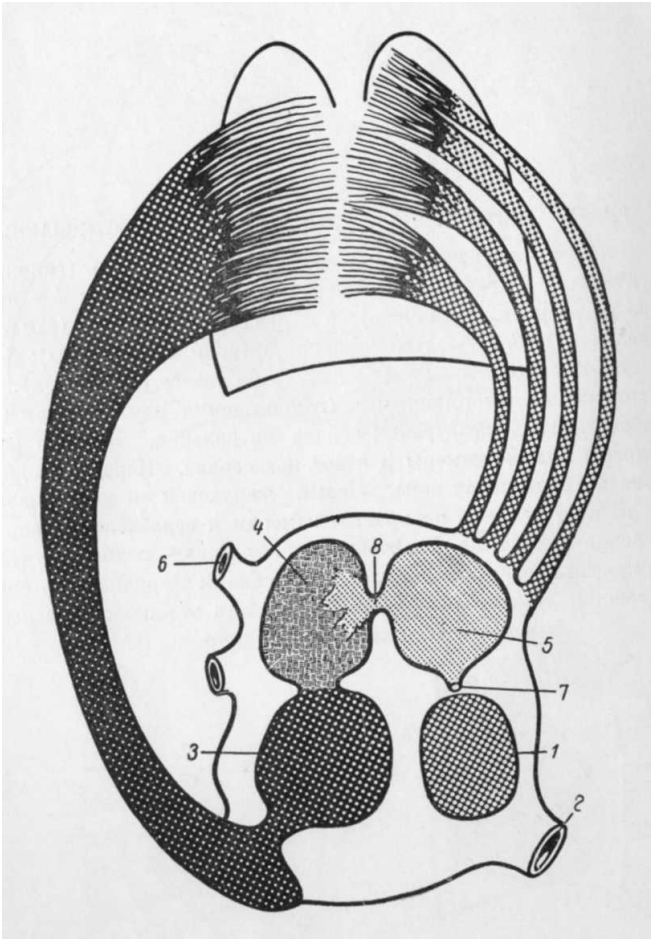
*1 - left ventricle; 2 - aorta (hypoplastic); 3 - right ventricle (dilated and hypertrophied); 4 - right atrium (significantly hypertrophied); 5 - left atrium (may be enlarged); 6, 7 — pulmonary arteries (increased diameter); 8 - atrial septal defect.*

*Explanation of the mechanism of hemodynamic disturbances. In systole of the left atrium, the blood, due to the greater pressure in it, partially enters the right atrium and into the right ventricle. This creates some overflow of blood into the cavities of the right heart, and hence the pulmonary artery system. The left ventricle receives less blood. The aorta is hypoplastic.*



**RADIOGRAPHS OF A PATIENT WITH ATRIAL SEPTAL DEFECT.**

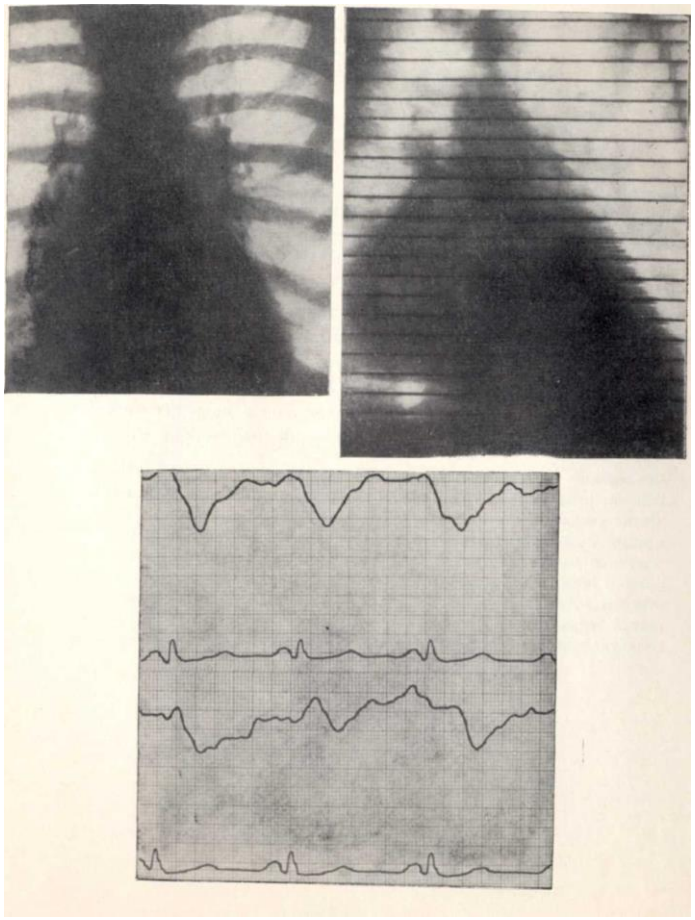
*Hypervolemia ("cherries" in the roots), bulging of the second cardiac arch on the left. In oblique projections, an increase in predominantly the right chambers of the heart and a hypoplastic aorta. Electrokymographic curves from the left (top) and right (bottom) atrium: a "shunt" wave on the right atrium curve in presystole and the beginning of systole, corresponding to which on the left atrium curve there is a deep presystolic decrease in the curve.*




**SCHEME OF HEMODYNAMIC DISTURBANCE IN LYUTENBASH SYNDROME** .

*1 - left ventricle (hypoplastic); 2 - aorta (narrow); 3 — a right ventricle (is sharply increased); 4 - right atrium (increased); 5 - left atrium (enlarged); 6 - superior vena cava; 7 - mitral opening (narrowed); 8 - atrial septal defect.*

*Explanation of the mechanism of hemodynamic disturbances. With a combination of congenital narrowing of the mitral orifice with an atrial septal defect, regardless of the size of the defect, there is a large shunt of blood from the left atrium to the right. Overflow with blood of the right chambers and the pulmonary artery leads to a noticeable increase in them. The left ventricle and aorta are hypoplastic. The left atrium is enlarged, as in acquired mitral stenosis.*

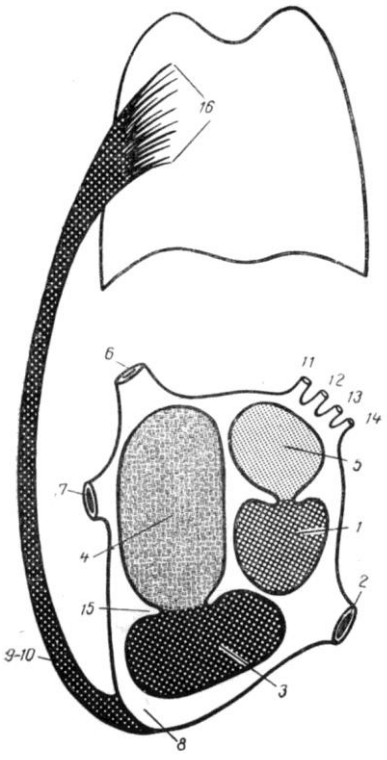


**RADIOGRAMS OF A PATIENT WITH LUTENBASH SYNDROME.**

*Gynorvolemia. Enlargement of both atria and right ventricle. On the electrokymographic curves of the left (top) and right (bottom) atria, there is a diastolic plateau on the curve of the left atrium and a "shunt" wave on the curve of the right atrium (the curve rises corresponding to the presystolic decrease in the left atrial curve).*

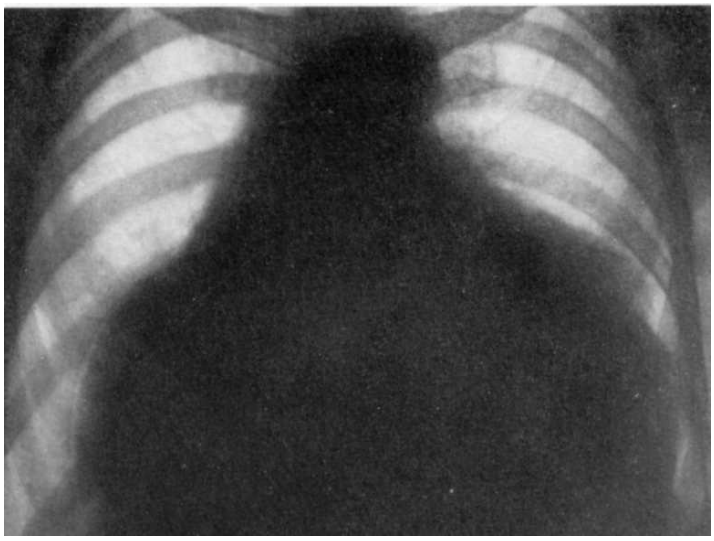
**SCHEME OF HEMODYNAMIC DISTURBANCE IN EBSTEIN DISEASE (formation of a tricuspid valve on the wall of the right ventricle with valve insufficiency).**

*1 - left ventricle; 2 - aorta; 3 - right ventricle (enlarged); 4 - right atrium (significantly enlarged); 5 - left atrium; 6.7 - superior and inferior vena cava (the mouth of the confluence expanded); 8 - pulmonary artery; 9, 10 - pulmonary arteries (narrowed); 11-14 - pulmonary veins; 15 - tricuspid valve (located ectopically with relative insufficiency); 16 - pulmonary pattern (depleted).*



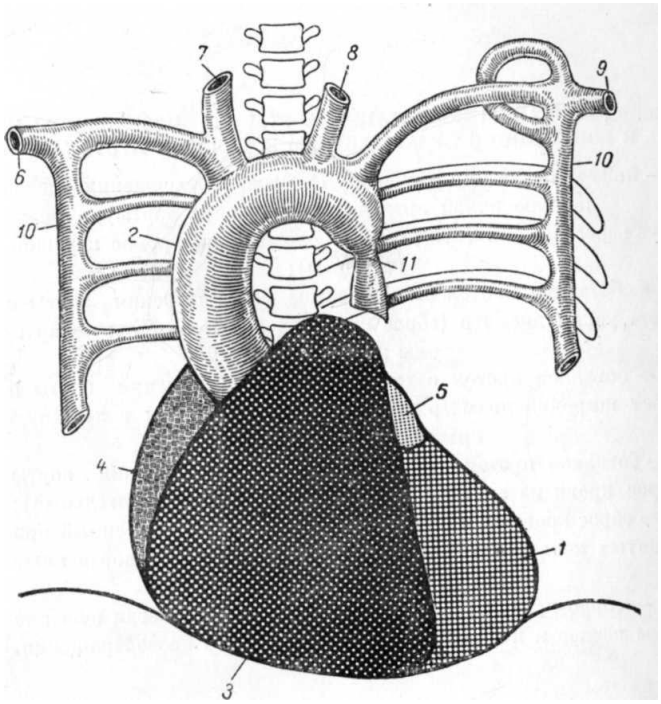

*Explanation of the mechanism of hemodynamic disturbances. Due to the enlargement of the cavity of the right atrium, the volume of circulating blood in the right cavities is increased, which in turn causes contraction and hypertrophy of the right cavities of the heart. The size of the heart is sharply increased (macrocar-day) with an apparent narrow*

*shadow of the vascular bundle. At the moment of right ventricular systole, as a result of insufficiency of the atrioventricular orifice, regurgitation of the blood column occurs, which leads to an unsharp expansion of the right atrium. At the same time, the pulmonary artery receives a small amount of blood, so the roots and pulmonary pattern are less pronounced than normal.*



**RADIOGRAPH OF A PATIENT WITH EBSTEIN'S DISEASE.**

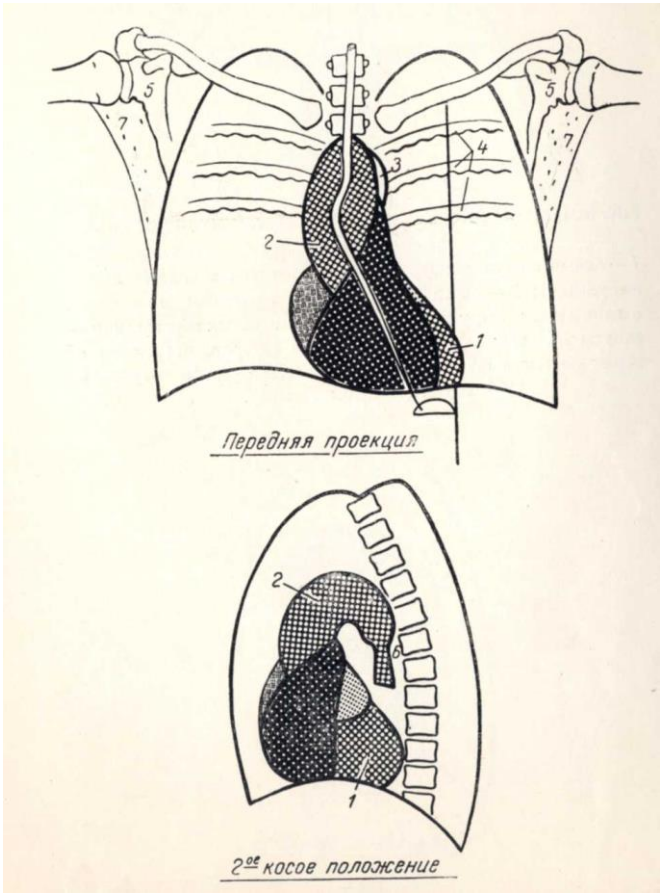
*The heart is significantly expanded in diameter, mainly due to the right atrium. The left ventricle is blocked by the right one, which is pushed aside by the right atrium.*




**SCHEME OF HEMODYNAMIC DISTURBANCE DURING COARCTATION OF THE AORT .**

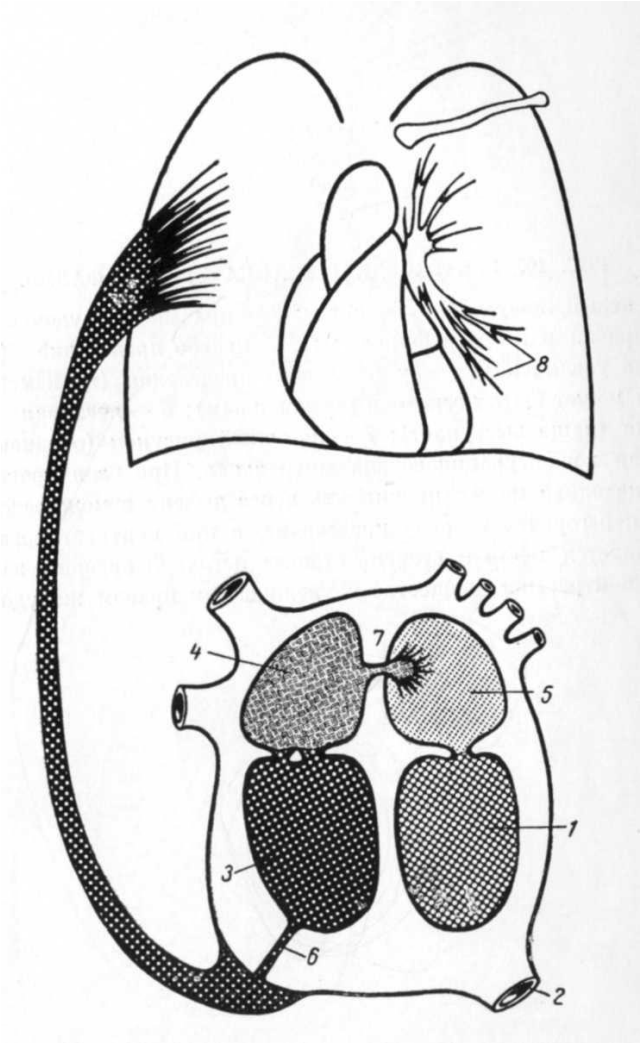
*1 - left ventricle (enlarged); 2 — an aorta (it is expanded to the place of narrowing); 3 - right ventricle; 4 - right atrium; 5 — an ear of the left auricle; 6 - right subclavian artery; 7 - right common carotid artery; 8 - left common carotid artery; 9 - left subclavian artery; 10 - internal thoracic artery; 11 — a place of narrowing of an aorta.*

*Explanation of the mechanism of hemodynamic disturbances. If the narrowing of the aorta is localized in the area of the isthmus, then its prestenotic section will be expanded in the same way as the blood vessels of the upper extremities and head extending from the aortic arch. Below the site of narrowing, the blood pressure in the aorta will not be increased and its lumen will be little changed. The left ventricle, encountering obstacles during systole, will hypertrophy to varying degrees, depending on the degree of narrowing of the aorta and the severity of collaterals. The remaining parts of the heart do not suffer if the narrowing of the aorta is not combined with other defects. As a result of blood overflow of the subclavian artery during coarctation of the aorta, the upper costal and intercostal arteries overflow with blood, which, expanding, cause further usuration of the posterior segments of the ribs. There are also combinations of narrowing of the isthmus of the aorta with non-closure of the ductus arteriosus. Depending on the localization of the narrowing of the aorta (above the duct or below), as well as the diameter of the open duct, there may be a shunt of blood from the aorta to the pulmonary artery or vice versa.*




## X-RAY DIAGNOSIS OF AORTIC COARCTATION.

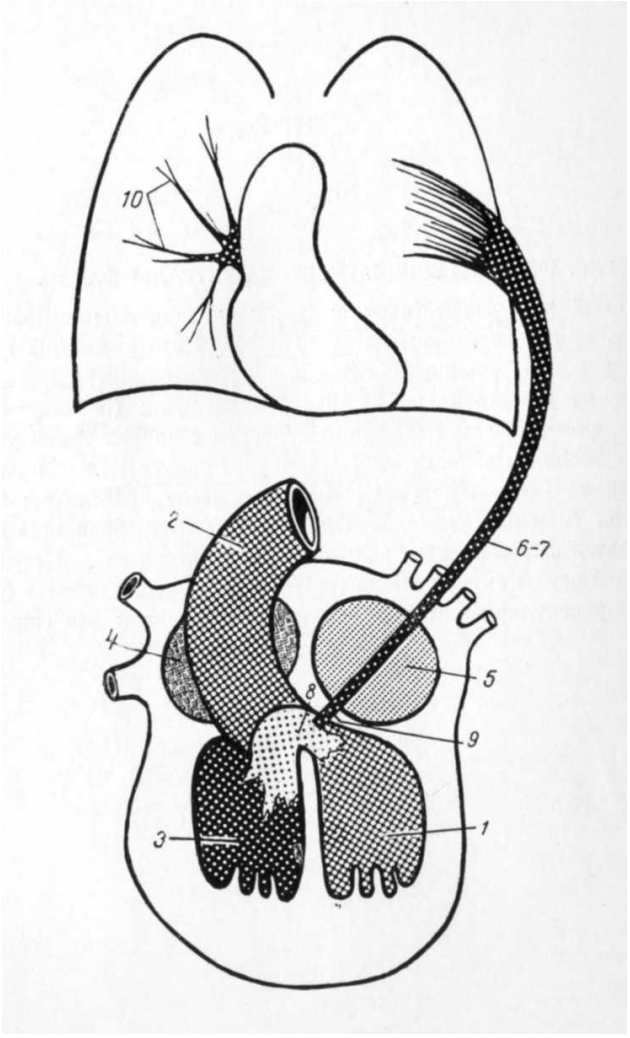
*1 - left ventricle (enlarged); 2 - aorta (enlarged, the left contour is sometimes formed not by the aortic arch, but by the dilated left subclavian artery);*
*3 - left subclavian artery; 4 - rear segments of the ribs (used);*
*5 - scapula (usura in the zone of the neck of the scapula); in — the place of coarctation of an aorta;*
*7 - soft tissues of the chest (against which shadows or areas of calcification of collateral vessels are sometimes determined).*




## SCHEME OF HEMODYNAMIC DISTURBANCE IN THE FALLOT TRIADE

*(valvular pulmonary stenosis, atrial septal defect and right ventricular hypertrophy).*
*1 - left ventricle; 2 - aorta; 3 - right ventricle (hypertrophied); 4 - right atrium (enlarged); 5 - left atrium (enlarged);*
*6 - narrowing of the pulmonary artery; 7 - atrial septal defect;*
*8 - pulmonary pattern (depleted).*

*Explanation of the mechanism of hemodynamic disturbances. Depending on the diameter of the opening in the atrial septum and the degree of narrowing of the pulmonary artery, the discharge of blood can occur from left to right or from right to left. So, if the narrowing of the pulmonary artery is expressed significantly, then the pressure in the right half of the heart is greater and the blood is discharged from right to left. In such cases, dilation and hypertrophy of the left ventricle develops.*

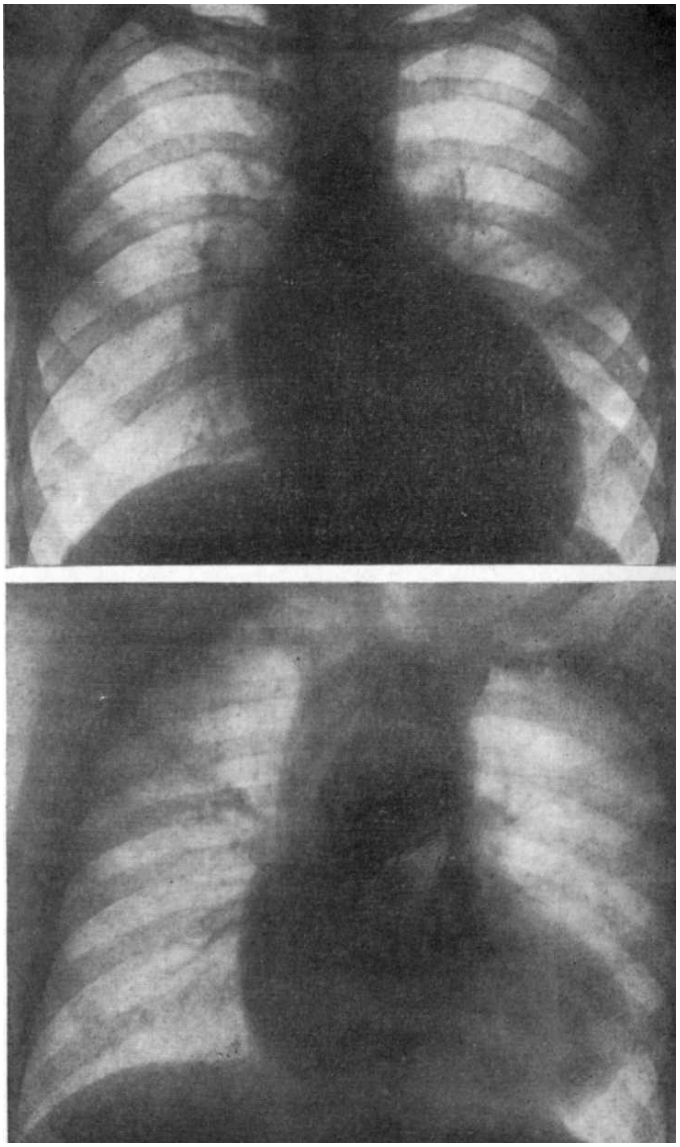



## SCHEME OF HEMODYNAMIC DISTURBANCE IN TETRADE OF FALLOT

*( pulmonary stenosis, often infundibular; high ventricular septal defect; aorta "sitting on top" of both ventricles, and right ventricular hypertrophy. Often combined with a right-lying aorta).*

*1 - left ventricle; 2 - aorta; 3 - right ventricle (enlarged, hypertrophied); 4 - right atrium (increased); 5 - left atrium; 6, 7 - pulmonary arteries (narrow); 8 — defect of an interventricular partition; .9 - narrowing of the pulmonary artery; 10 - pulmonary pattern (depleted).*

*Explanation of the mechanism of hemodynamic disturbances. Due to the uneven division of the bulb into the aorta and the pulmonary artery, the latter is significantly narrowed, and the aorta is correspondingly dilated. Due to the narrowing of the pulmonary artery, there is a sharp dilation and hypertrophy of the right ventricle. The pulmonary circulation receives less blood than the aorta. The main compensation factor in this case is the development of collateral circulation in the pulmonary circulation. The impoverishment of blood in the pulmonary circulation leads to pulmonary hypotension and anoxemia.*



**RADIOGRAMS OF A PATIENT WITH FALLOT'S TETRAD.**

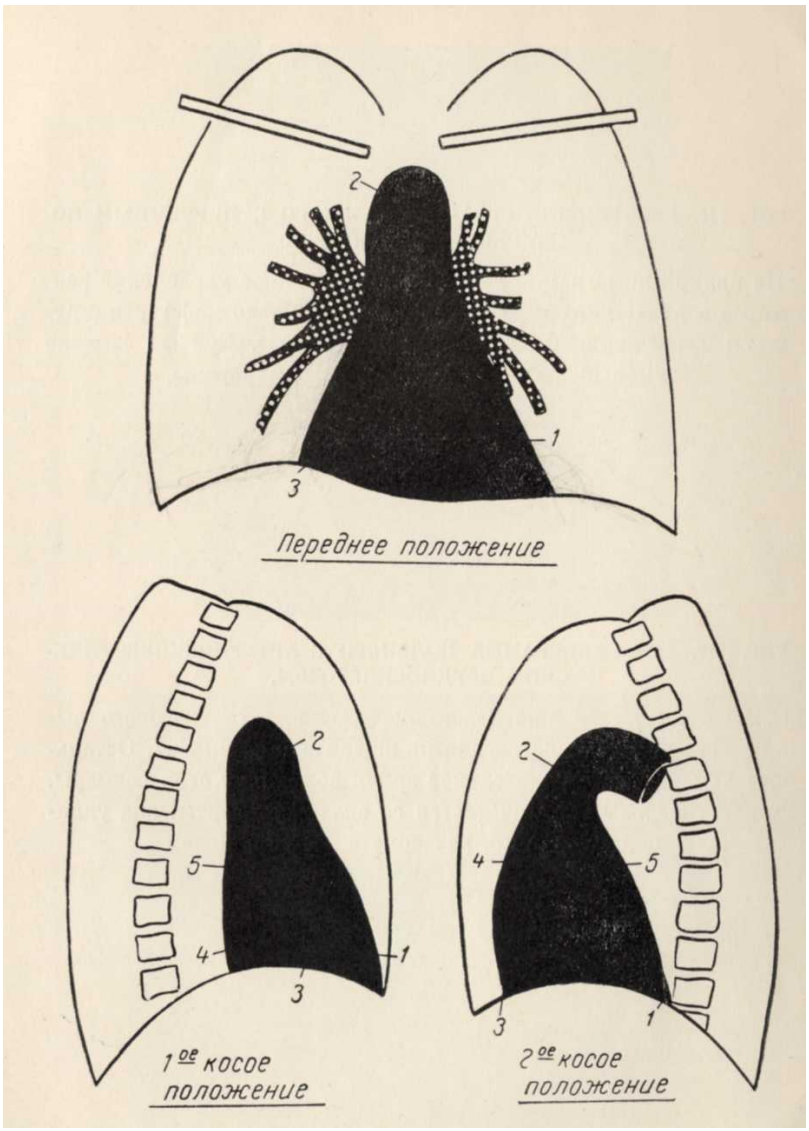
*The lung pattern is depleted. The right and left branches of the pulmonary artery are poorly differentiated (narrow). The heart looks like a "wooden shoe"; sinking in the place of the II cardiac arch on the left. On the internal angiogram, one-stage execution of the aorta with the chambers of the right heart and infundibular stenosis of the pulmonary artery are noted. The combination of this defect with an atrial septal defect is called Fallot's pentade. Both clinically and radiologically there are no characteristic data, and I carry out the diagnosis using angiography. This group of defects is rare, very diverse and does not have a clear clinical and radiological semiotics, which is why they are recognized only with the help of angiography and probing. In view of this, we present only schemes of hemodynamic disturbances.*

***Myocarditis***

Inflammatory disease of the heart muscle. Depending on the anatomical features, there are: parenchymal, interstitial, focal, diffuse myocarditis.

With myocarditis, there is a decrease in the contractility of the myocardium, stagnation in the pulmonary and systemic circulation.

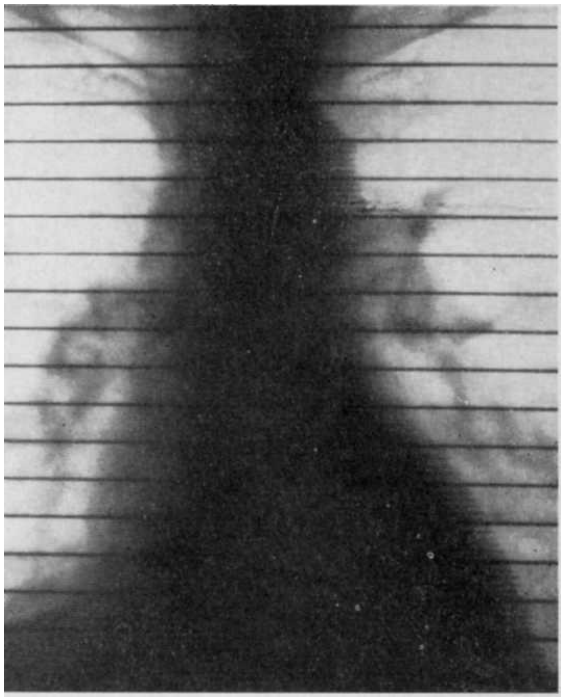
Radiography: an increase in all chambers of the heart (larger in the ventricle), straightening of the arcs and their smoothness. Cardio-diaphragmatic angles become dull, the amplitude of contractions decreases.




## X-RAY DIAGNOSIS OF MYOCARDITIS, MYOCARDIAL DYSTROPHY AND MYOCARDITIC CARDIOSCLEROSIS.

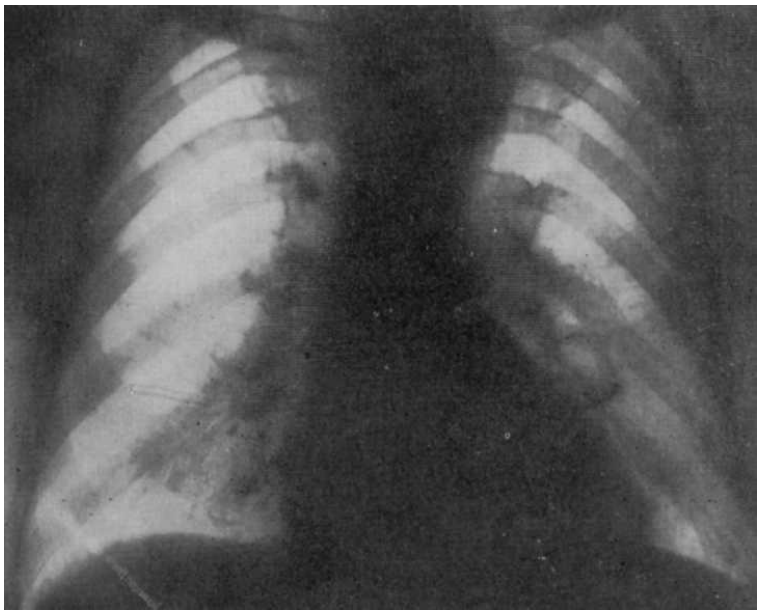
*1 - left ventricle; 2 - aorta; 3 - right ventricle; 4 - right atrium;*
*5 - left atrium.*

*These essentially different pathological processes in the heart muscle give the same x-ray picture: an increase in all chambers of the heart (more ventricles), straightening of the arcs and their smoothness. Cardio-diaphragmatic angles become dull, the amplitude of contractions decreases. Depending on the depth of myocardial damage, the severity of these symptoms will be different.*



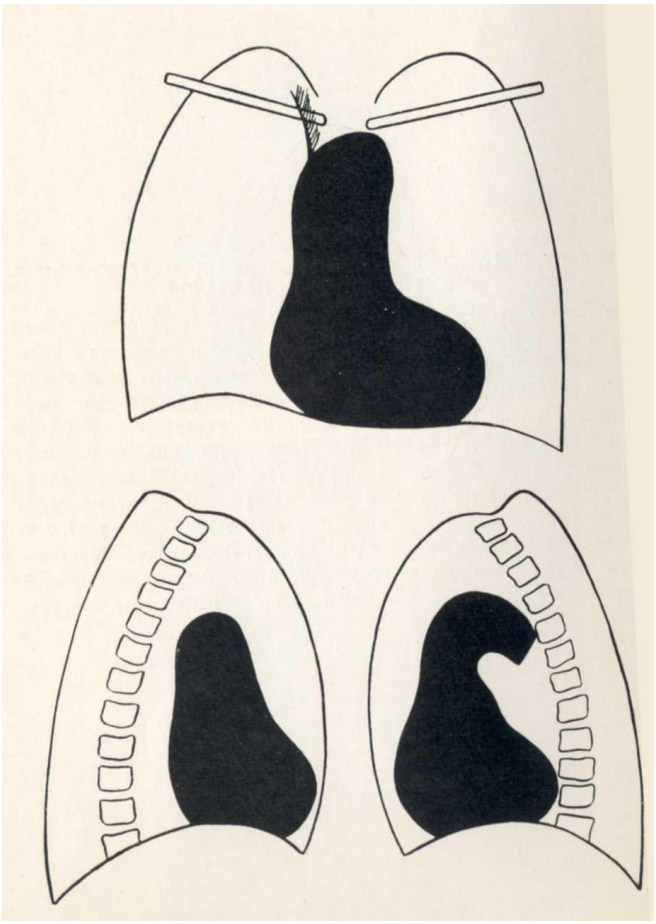
**X-RAY MOGRAM OF A PATIENT WITH PRIMARY MYOCARDIAL LESION.**

*A direct kymogram reveals a moderate increase in the size of the heart; the arcs of the heart are straightened, poorly differentiated; cardio-diaphragmatic angles are obtuse. The teeth are noticeably reduced in amplitude and deformed.*



**RADIOGRAPH OF A PATIENT WITH ARTERIOSCLEROPTIC CARDIOSCLEROSIS.**

*There is an increase in the left ventricle, the arc of which is straightened, and the apex of the heart is raised and blunted. The remaining chambers of the heart retain their size for a long time. Cardiosclerosis is often combined with sclerosis of the aorta: it is elongated, curved, deployed and compacted.*



**X-RAY DIAGNOSIS OF HYPERTENSION HEART.**

*Expression of the cardiac waist. Elevated apex of the enlarged left ventricle. The expansion of the ascending aorta is often accompanied by the expansion of the brachiocephalic (nameless) artery, which gives an additional shadow at the upper right pole of the aortic shadow. In the early stage of the disease, radiomorphological changes in the heart are absent. Quite quickly, signs of cardiosclerosis and aortic sclerosis join.*



**RADIOKIMOGRAMS OF PATIENTS WITH HYPERTENSION STAGE II-III.**

a — *moderate enlargement of the left ventricle with rounding of its arc (hypertrophy); pulsation is somewhat tense. There is an increase in pulsation in the ascending aorta; b—an increase in the size of the heart is more pronounced; the arch of the left ventricle is somewhat straightened, the apex is raised and blunted. Pronounced elongation, thickening, expansion, curvature and unfolding of the aorta (its sclerosis). In the region of the apex of the heart, the teeth are clearly reduced in amplitude and grossly deformed (signs of cardiosclerosis). There is an increased pulsation in the ascending aorta. Expansion of the vascular bundle to the right due to the secondary expansion of the brachiocephalic artery with a pronounced pulsation along its outer contour.*

***Pericarditis***

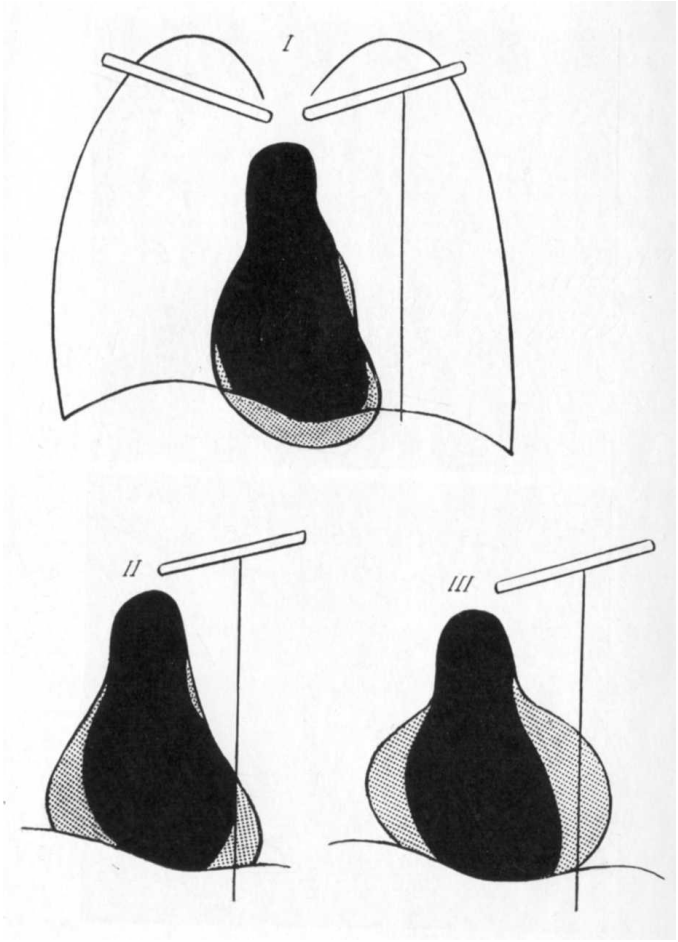
There are dry (or fibrinous) and exudative (or exudative).

The diagnosis of dry pericarditis is made on the basis of the clinic, ECG, phono- and echographically. With the accumulation of exudate in the pericardial cavity (more than 30 мм), the shadow of the heart increases.

Radiography: smoothness of the arcs, the heart shadow acquires a spherical shape, shortening of the vascular bundle; expansion of the superior vena cava; the cardio-diaphragmatic angle becomes sharper and deeper.

X-ray: the pulsation is sharply weakened.

ECHOCG, CT, MRI: direct visualization of fluid in the pericardial cavity




**X-RAY DIAGNOSIS OF EXUDATIVE PERICARDITIS.**

*The picture is different depending on the amount of effusion in the pericardial cavity. / - in the initial phases of the effusion, the liquid is located in the lower pocket and rises in a thin layer in front and behind into the upper pocket. 15 of this stage (up to 500 cm $^3$ ), only the apex of the heart sinks down and the smoothness of the cardiac gallium is noted.*

*I? first oblique projection - Narrowing of the retrocardial space in the lower section with straightening of the arch of the inferior vena cava. Changes in pulsation, as a rule, are not observed;*

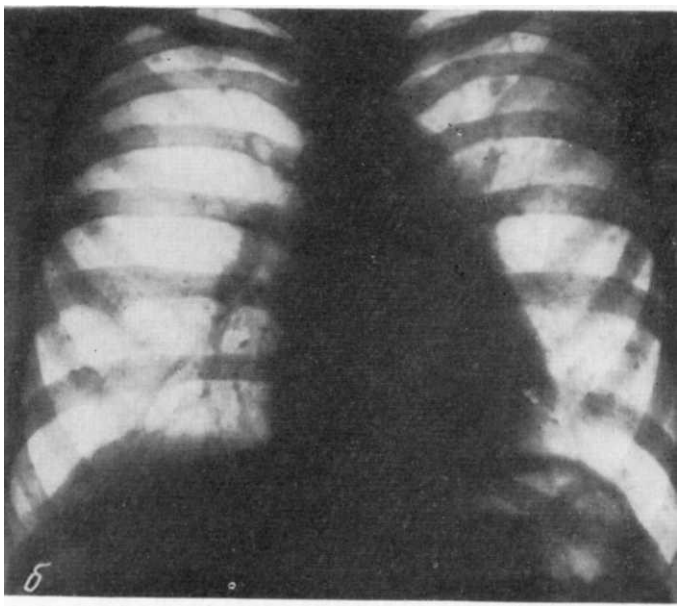
*//—a pronounced stage of fluid accumulation, when the lateral and posterior sinuses of the heart shirt are filled (from 500 to 1000 cm $^3$ ). The borders of the heart are moved to the left and right, the shadow of the vascular bundle is shortened. The length and diameter of the heart are either equal, or the diameter is greater than the length. Attention is drawn to the roundness of the arcs with a small amplitude of contractions. A characteristic sign of exudative pericarditis appears - the preservation of pulsatory movements on the vascular bundle and the almost complete absence of pulsation along the arcs of the heart;*

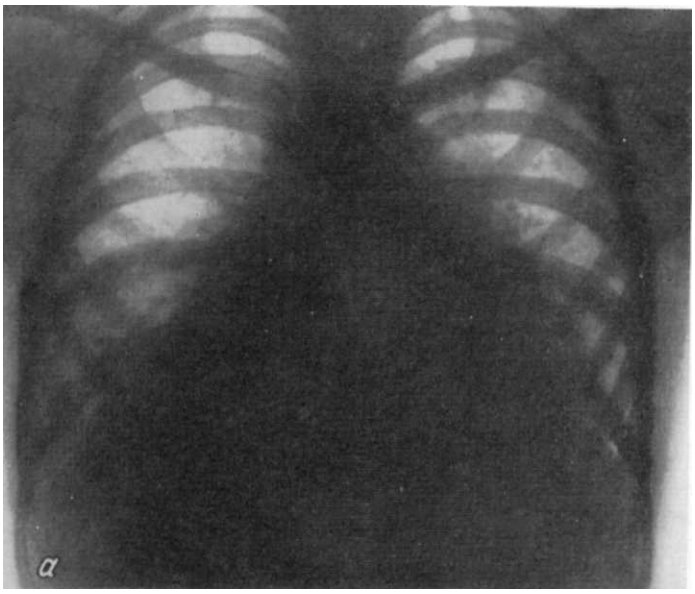
*/// - a pronounced stage of fluid accumulation (more than 1000 cm $^3$ ); the latter performs mainly the lateral sinuses. The heart takes on a spherical shape with a sharply shortened vascular bundle. The diameter of the heart is greater than the length. Cardio-diaphragmatic angles are sharpened. Pulsatory movements along all contours of the heart are absent, weakened on the vessels*

.

## RADIOGRAMS OF A PATIENT (TEENAGER) WITH EXUDATIVE PERICARDITIS OF TUBERCULOSIS ETIOLOGY.

a - *the phase of maximum accumulation of fluid in the heart shirt; b—the same patient after 5 months: the shadow of the heart is small*



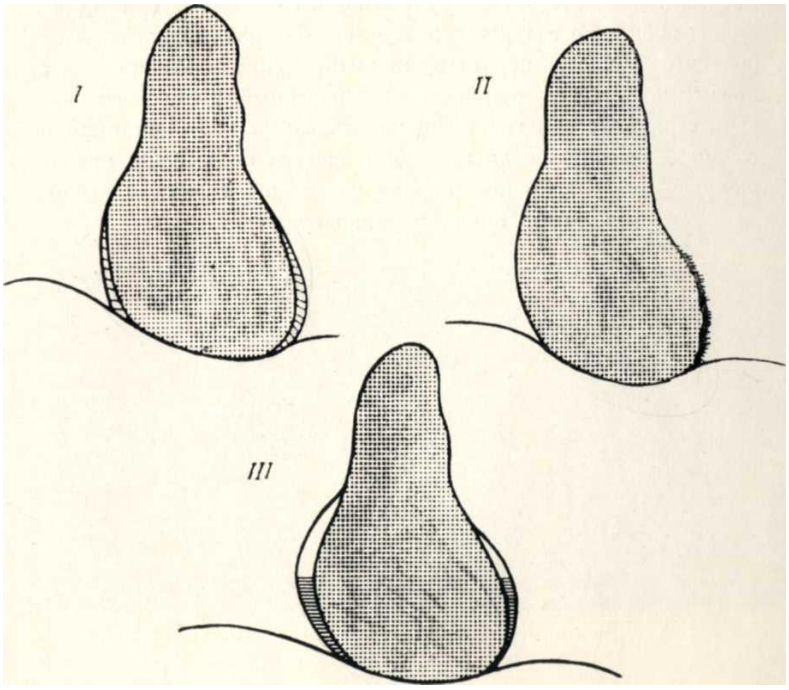



*Adhesive constrictive pericarditis.*

Radiography and fluoroscopy: calcification of the pericardium; change in the shape and decrease in the size of the heart shadow; expansion of the superior vena cava; absence of pulsation along the contours of the cardiac shadow while maintaining pulsation along the contours of the aorta.

CT: thickening , compaction, calcification of the heart shirt.

ECHOCG: no movement of the pericardium; paradoxical movement of the interventricular septum in early diastole; collapse of the inferior vena cava after a deep breath is less than 50%.

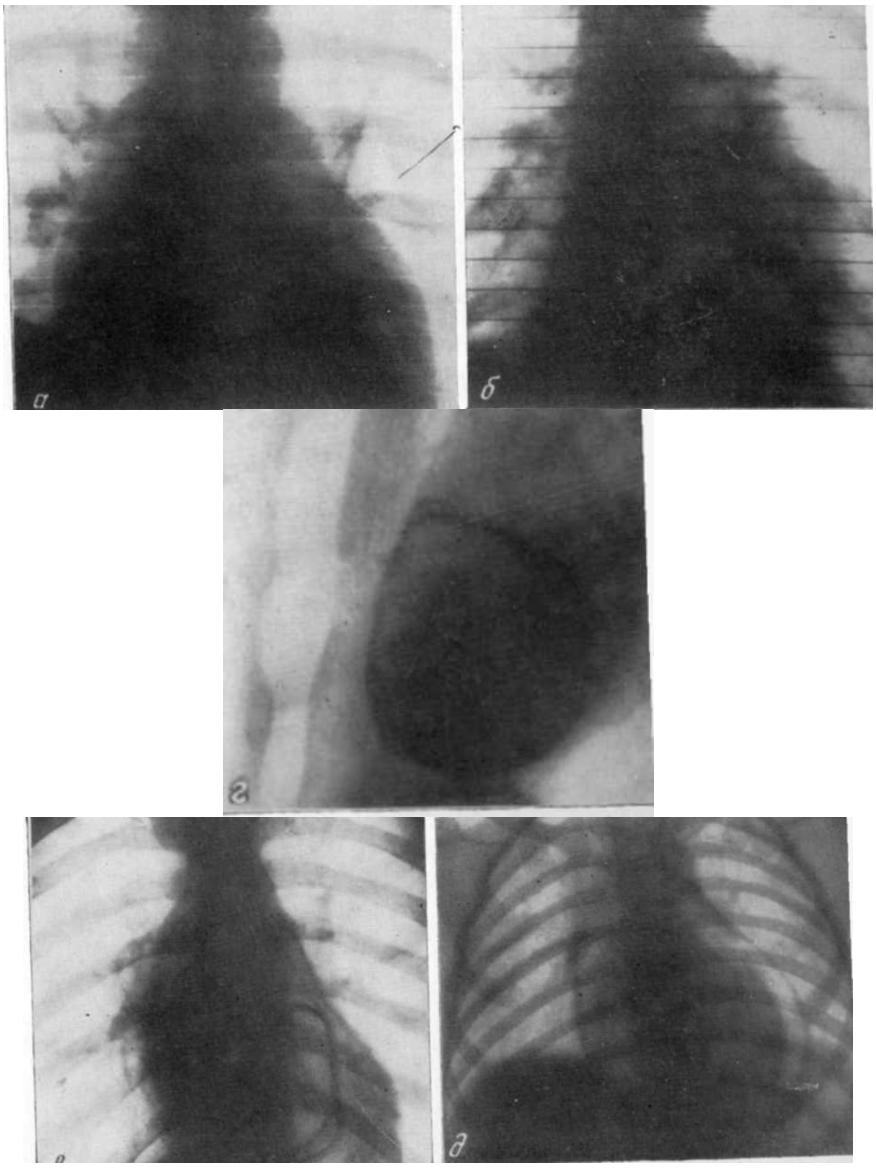



**X-RAY DIAGNOSTICS OF THE CONSEQUENCES OF PERICARDITIS.**

*/ - adhesions between the sheets of the pericardium with obliteration of the cavity. Sometimes islands of lime are detected in some area along the contour of the heart shadow ("armored heart");*

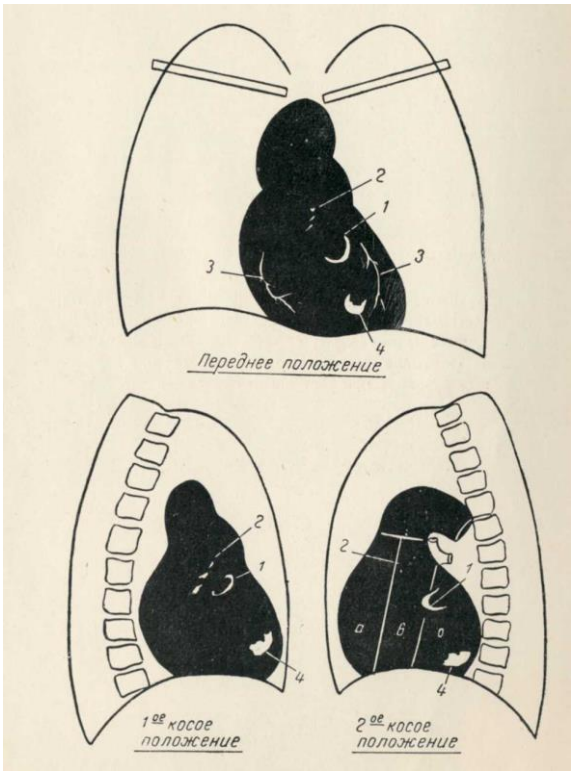
*// - the presence of adhesions with the mediastinal pleura causes displacement of the shadow of the heart, uneven contours or fuzzy arcs;*

*/// - hydro-pneumopericarditis - the presence of gas and fluid level in the pericardial cavity .*



**RADIOGRAMS OF PATIENTS WITH PERICARDITIS .**

***a*** *— roentgenogram of a patient with constrictive pericarditis: complete absence of teeth along all contours of the heart and teeth are visible along the vascular bundle;* ***b*** *— roentgenogram of a patient with pleuro-pericardial adhesions along the entire left contour of the heart; the latter is uneven, the teeth are fuzzy; the shadow of the heart is slightly shifted to the left; c -* ***d*** *- "armored heart", - strips of lime are clearly visible along the contour of the right ventricle;* ***e*** *- wound of the pericardium with the formation of hydro-pneumopericarditis .*




**CALCIFICATION OF THE HEART.**

*1 - calcification of the bicuspid valve in the form of a U-shaped figure or the letter "c"; 2 — calcification of semilunar valves of an aorta in the form of separate petrificates;* 3 *- calcification in the wall of the left ventricle in the form of linear shadows of the coronary vessels;* 4 *- the same in the form of a calcification conglomerate. Calcifications of the heart can be localized in any of its departments, more often in the valvular apparatus. To determine the topic of calcification, one should focus on segments* a - b - *c, formed by two parallel lines dividing the heart array in the second oblique position into three segments. Of great importance in identifying calcifications is tomography and transillumination on an apparatus with an electron-optical converter.*

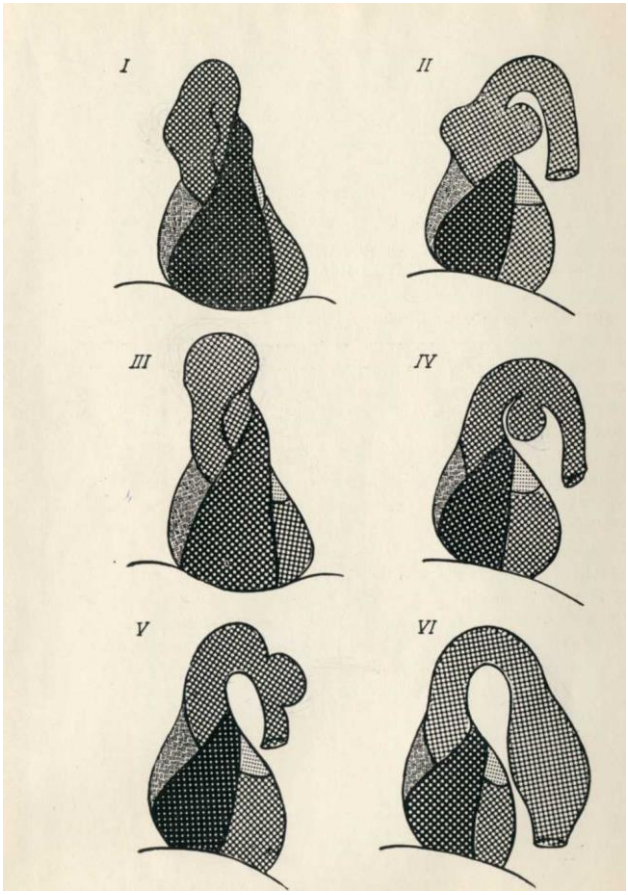
***Vascular examination***

*Aneurysm of the thoracic aorta.*

Radiography: local expansion of the upper part of the median shadow of a semicircular, semi-oval shape with even, clear contours, inseparable from the aorta in any projection and having independent pulsation.

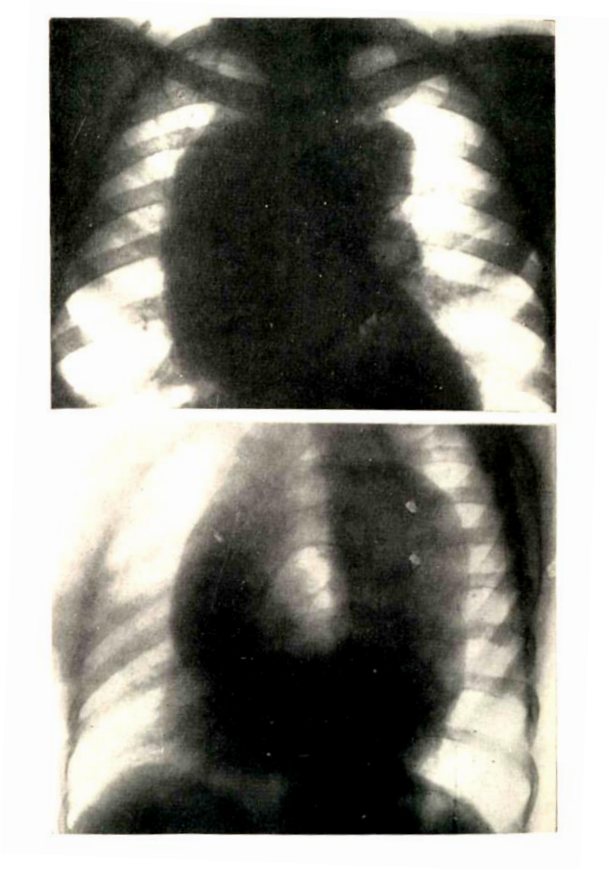
MR-aortography, contrast CG-aortography: allows to establish an aneurysm with high accuracy, to characterize in detail the shape, diameter, length, condition of paroarticular tissues, separation of the walls, thrombotic masses.

X-ray contrast aortography is limited by the ability to assess only the lumen of the aorta and carries the risk of developing cerebral artery embolism, rupture of the aneurysmal sac.




**ANEURYSM BY LOCALIZATION.**

***I , II*** *- aneurysm of the ascending aorta, its anterior or posterior wall;* ***III , IV*** *- in the zone of the aortic arch, its upper or lower wall;* ***V*** *- in the zone of the descending part of the aorta;* ***VI*** *- in the zone of the thoracic aorta. X-ray diagnostics of aortic aneurysms is based on the inseparability of an additional formation from the aorta in a multi-axial study of the patient. Recognition of aneurysms depends on the location, shape and size of it. Fusiform aneurysms are easier to recognize than saccular aneurysms located in the ascending and descending sections than in the region of the aortic arch. A valuable diagnostic sign of an aneurysm is the detection of calcifications of its wall (deposition of lime in parietal thrombi), in the form of linear shadows along the contour of the pathological formation. An important point in the diagnosis of aneurysms is a contrast study of the esophagus: a change in its position is always observed when aneurysms are localized in the region of the arch, descending section and large aneurysms of the ascending aorta directed posteriorly. To aid in the diagnosis, tomography, pneumomediastinography and aortography are used.*

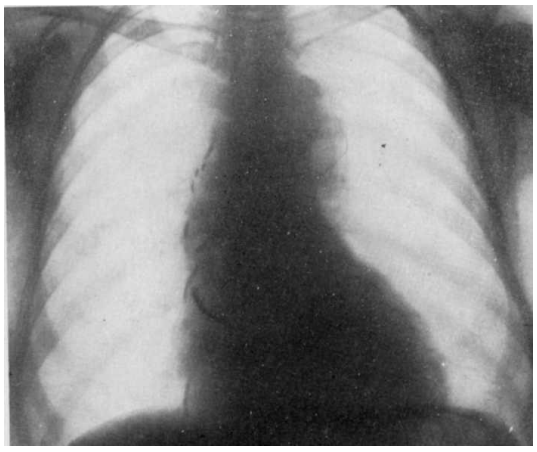


**RADIOGRAMS OF A PATIENT WITH MESAORTHITIS AND ANEURYSM.**

*The aorta throughout the thoracic region is sharply and unevenly expanded; the intensity of its shadow is increased (mesarthritis). In addition, there is an aneurysm located in the arch and descending part of the aorta. Islets of lime in the "beak" zone.*

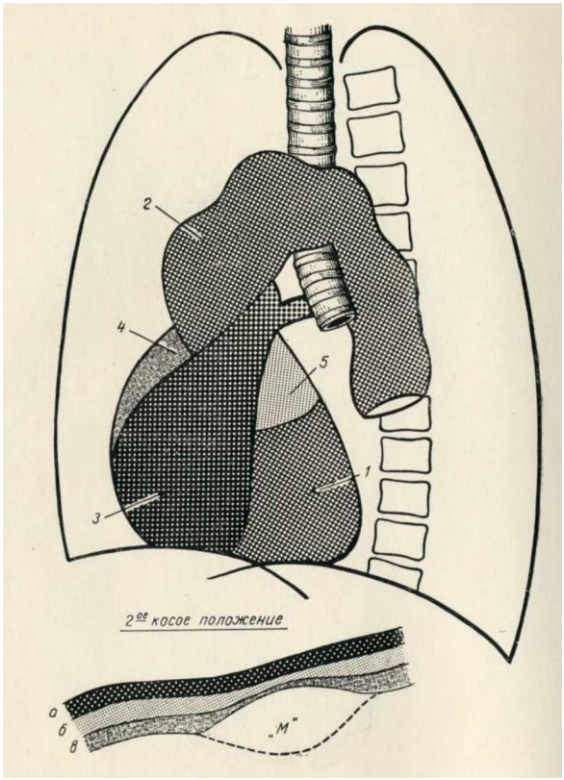
*atherosclerosis of the aorta.*

Radiography: in the ascending aorta various forms of lime inclusions. The shadow of the aorta is enlarged, elongated.



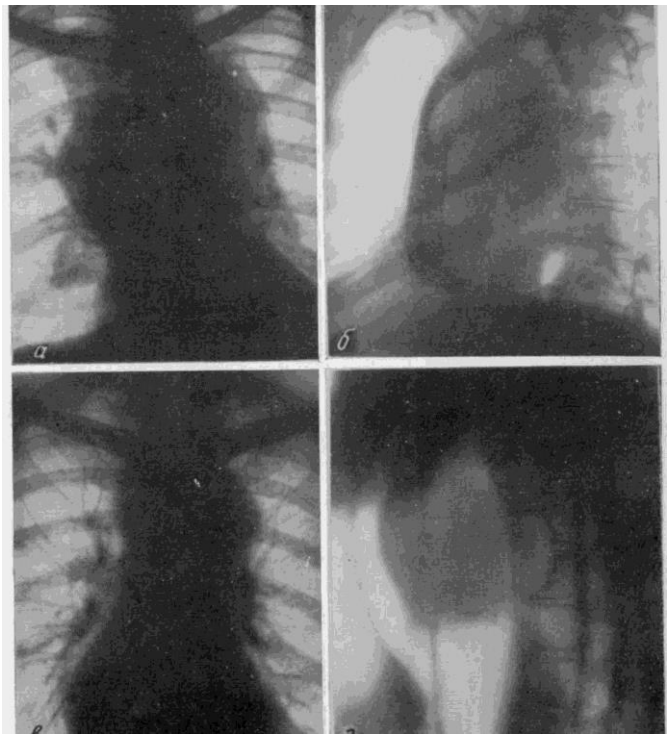
**RADIOGRAPH OF A PATIENT WITH CALCIFICATION OF THE AORTA WALL (ASCENTRAL DEPARTMENT) OF ATHEROSCLEROTIC ETIOLOGY.**

*In the ascending aorta, there are many different forms of lime inclusions.*




**syphilitic damage to the aorta.**

**1** - *left ventricle;* **2** - *aorta (serpentine);* **3** - *right ventricle;* **4** - *right atrium;* **5** - *left atrium:* **a** - *inner shell;* **b** - *middle shell; c - outer shell;* **"M"** - *protrusion of the wall. The disease is a manifestation of visceral syphilis. The process captures the middle shell, hence the name - mesaortitis.*




**RADIOGRAMS OF PATIENTS WITH SYPHILITIC MESAORTHITIS AND AORTIC ANEURYSM**

*a — b — the aneurysm occupies the ascending, arch and partially descending parts of the aorta. At the same time, the usuration of the sternum*

*handle in the second oblique position is clearly visible; c — **d** — saccular aneurysm originating from the upper wall of the arch and the descending aorta. On the lateral tomogram, the trachea is pushed forward, separate clumps of lime, mainly along the outer contours of the aneurysm, and the bodies of two thoracic vertebrae are usurated.*

*Veins of the lower extremities.*

Thermography: indicated for deep vein thrombosis. Normal t gradient between thigh and foot 4°C. With pathology, t of the limb increases.

Radionuclide method: test plus, if the difference in the concentration of radiopharmaceuticals in the area under study exceeds that in the symmetrical area of the other limb by 20%, and the difference persists for more than 24 hours.

Contrast X-ray phlebography reveals the displacement of the veins, the unevenness of their contours, the appearance of filling defects in them, occlusion

**Arteriogram.**

**Picture of normal arteries of a shin.**


**Phlebogram . Thrombosis deep veins .**

*but — multiple blood clots ( specified arrows ) in femoral And iliac*

*veins ; b — filter ( specified arrow ) in bottom hollow vein .*

***Heart contusion***

ECHOCG: regional deterioration of contractility and a decrease in ventricular ejection fractions of the heart; a zone of myocardial contusion with a heterogeneous echostructure with the inclusion of small echo-negative areas caused by edema and hemorrhages.

Myocardial perfusion scintigraphy: myocardial areas with reduced accumulation of radiopharmaceuticals.

*Rupture of the outer walls of the heart.*

ECHOCG, CT, MRI: direct visualization of fluid (blood) in the pericardial cavity.

Radiography: a general increase in the cardiac shadow, which acquires a ball shape; smoothness of the arcs along the contours of the heart shadow; shortening of the vascular bundle; expansion of the superior vena cava.

*Rupture of the thoracic aorta.*

MR aortography, contrast CT aortography: discontinuity, dissection of the aortic wall; formation of a pseudoaneurysm; exit of CV beyond the aorta.