Department of "Visual diagnostics"

Radiological research methods and radiological semiotics of acquired diseases of the mitral valve

Almaty 2021

Anatomy of the heart

The wall of the heart consists of three membranes

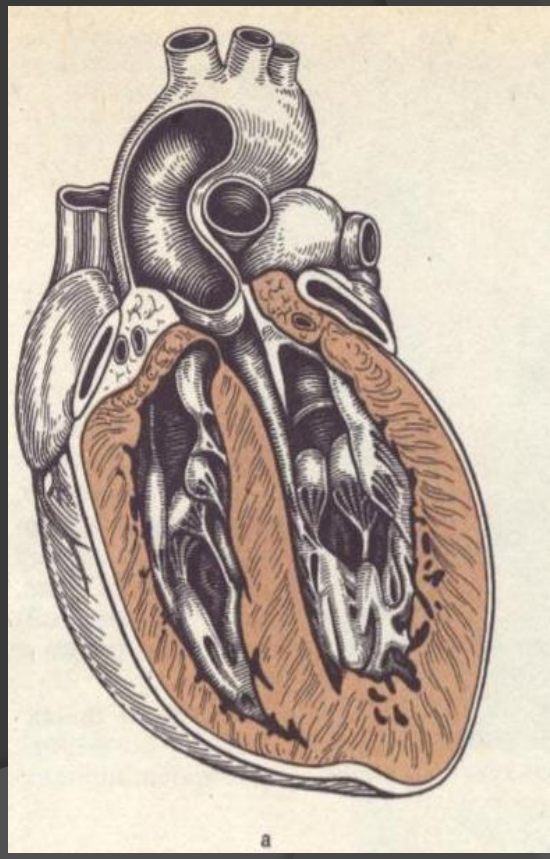
- endocardium (endocardium) – connective fabric with a large number of elastic fibers and smooth muscle cells, endothelial layer

All heart valves - endocardial folds mitral, aortic, pulmonary,tricuspid

- myocardium (miocardium)
- pericardium (pericardium) - serous membrane

Heart

- left atrium - atrium s.
- right atrium - atrium d.
- left ventricle - ventriculus s.
- right ventricle - ventriculus d.



Anatomy of the heart

Right atrium

the veins of the great circle flow blood circulation superior vena cava - v. cava s. - collects blood from the head, neck, upper limbs and chest wall inferior vena cava - v. cava i. - carrying blood from the lower extremities, organs and walls of the abdominal cavity

Left atrium

4 pulmonary veins flow (2 from each lung) that carry arterial blood from the

Anatomy of the heart

- Right ventricle - pulmonary artery exits

- The left ventricle exits the aorta

Radiological methods of diagnostics of diseases of the heart and large vessels

Non-invasive

- Radiography
- Fluoroscopy
- Echo-CG
- RCT, SCT, MSCT
- MRI
- Perfusion Scintigraphy, Radionuclide AG, PET

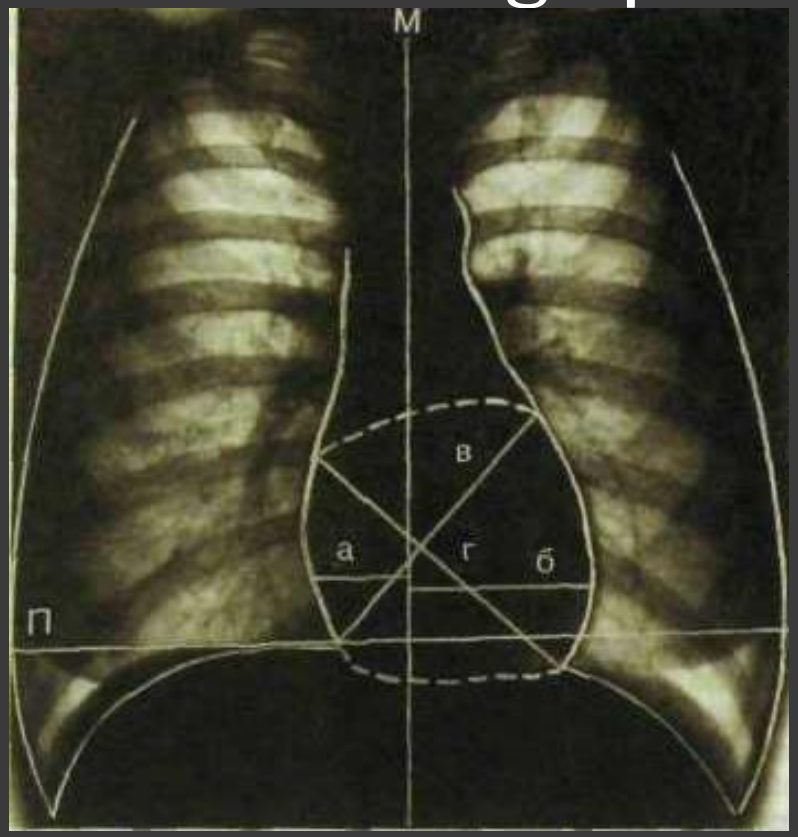
Invasive

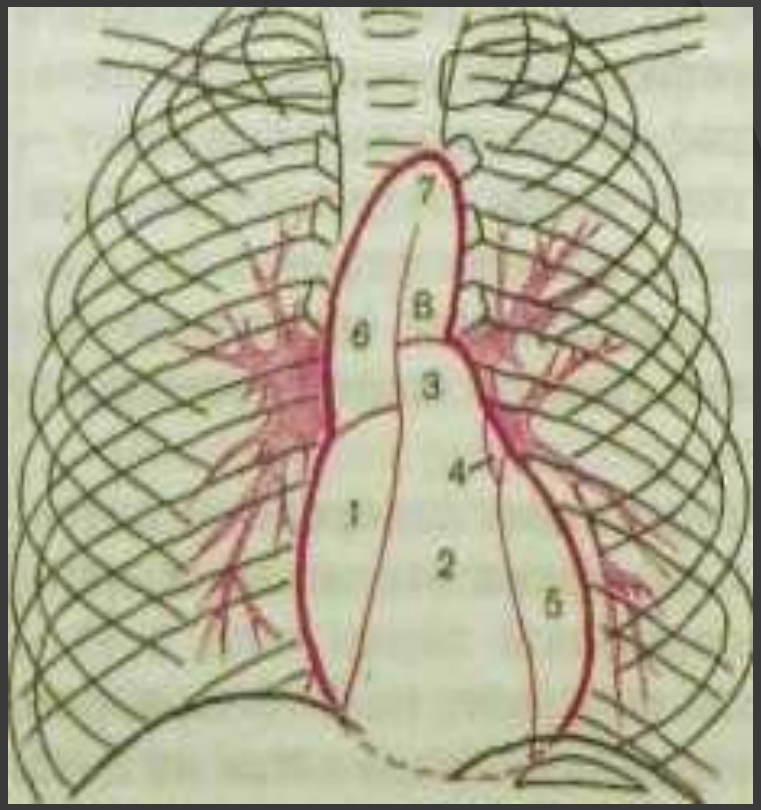
- AG, CG
- ultrasound with contrasting

X-ray, fluoroscopy

- Condition of lung tissue and pulmonary pattern (pulmonary circulation)
- Position, shape, size of the heart, diameter of large vessels
- Study of the shape of the cardiovascular shadow - the ratio of the cavities of the heart and large vessels
- Study of heart function – contraction myocardium - direct observation of the screen - fluoroscopy with contrasting the esophagus

Anterior radiograph of the heart and a diagram





a - right transverse dimension of the heart shadow (MR)

b - left transverse dimension (ML)

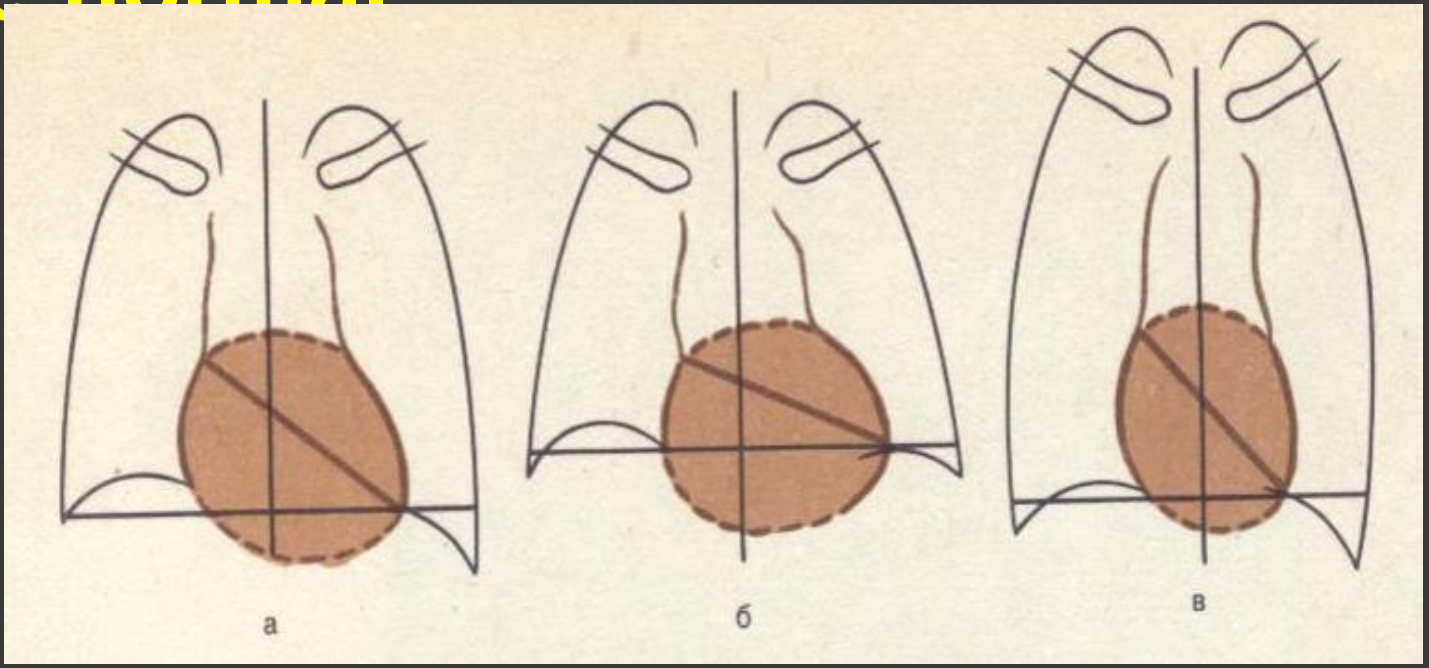
в - oblique size

g - longitudinal heart

Chart of basic measurements of the heart

- Of the proposed options for measuring the shadow of the heart, the most important is the determination of the dimensions of the length and diameter
- The length is a line running from the apex of the cardiovascular angle on the right to the apex of the heart
- The cross section is the sum of two linear measurements - horizontal lines running perpendicular to the median sagittal plane from the most distant points of the right and left curvature of the heart
- The length of the heart in men is 12-13 cm
- Diameter - 11 - 12 cm
- The length and diameter of the heart in women is 1 cm

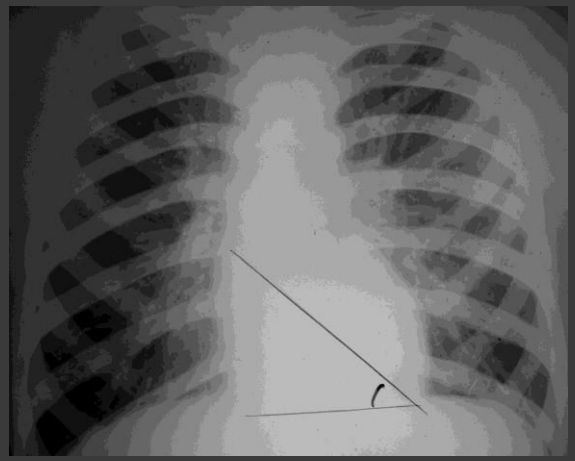
Variants of the location of the heart are normal

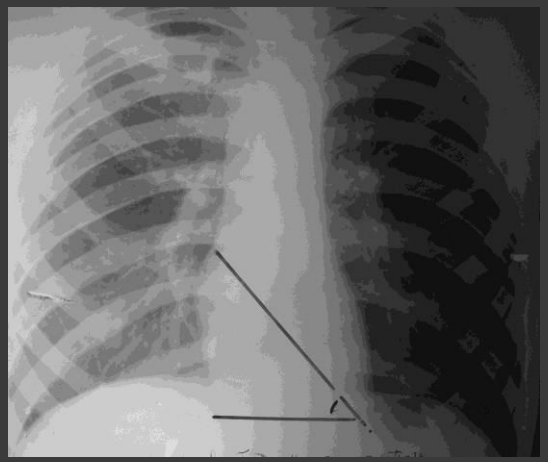


A - oblique location of the heart (normostenic);

B - horizontal position of the heart (hypersthenic);

C- vertical arrangement of the heart (asthenic)





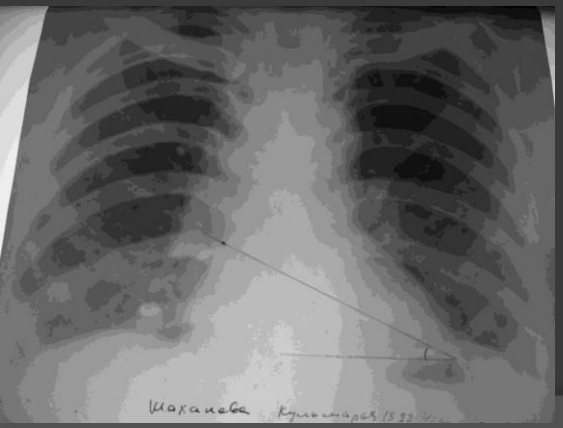
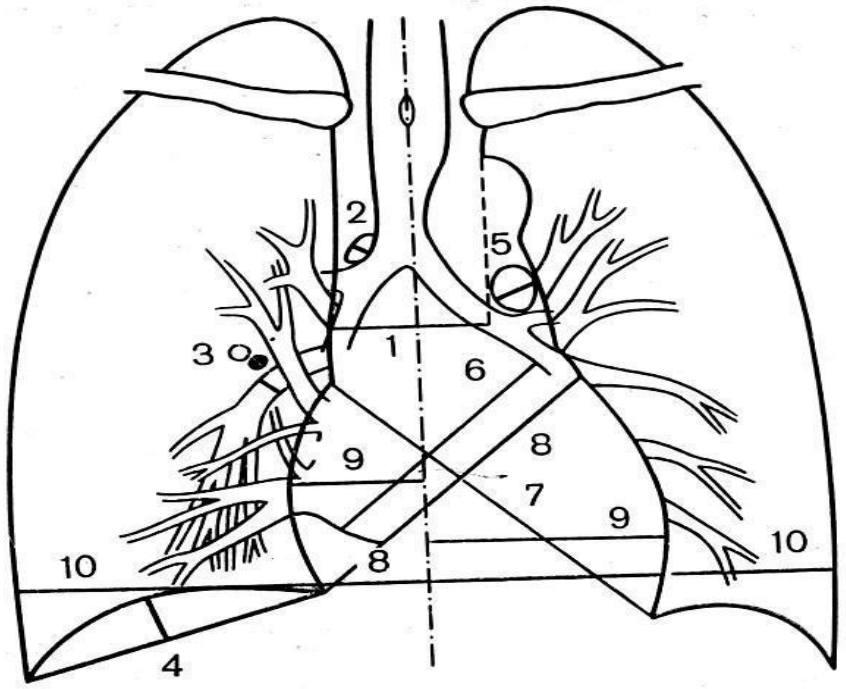
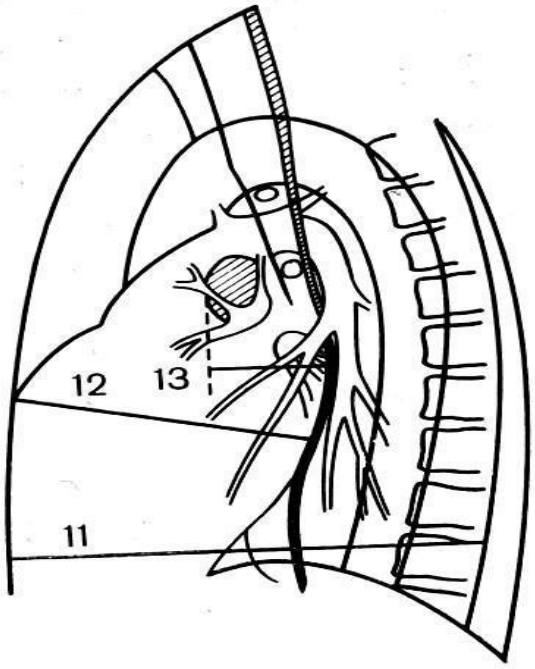


Chart of basic measurements of the heart

- Normosthenic - the angle of inclination of the longitudinal axis of the heart shadow to the diameter - 43-48 °MR / ML - 1: 2
- Asthenic - angle - 49-56 °MR / ML - 1: 1.8
- Hypersthenic - 39-42 °MR / ML - 1: 2.3

Radiometric dimensions that can be determined on a radiograph





Стандартные размеры, определяемые на рентгеновском силуэте сердца в передней и левой боковой проекциях.

1 — ширина «сосудистой ножки»; 2 — поперечник непарной вены; 3 — поперечник правой легочной артерии междолевой ствол); 4 — кривизна правого купола диафрагмы; 5 — диаметр левой легочной артерии; 6 — фронтальный диаметр левого предсердия; 7 — длинник сердца (L); 8 — поперечник (базальный диаметр) сердца (Q); 9 — правая (Tr) и левая (Tl) части горизонтального поперечника сердца (T); 10 — максимальный поперечник груди (Th); 11 — глубинный (сагиттальный) поперечник груди; 12 — глубинный диаметр сердца; 13 — сагиттальный диаметр левого предсердия.

X-ray of the heart with contrasting esophagus

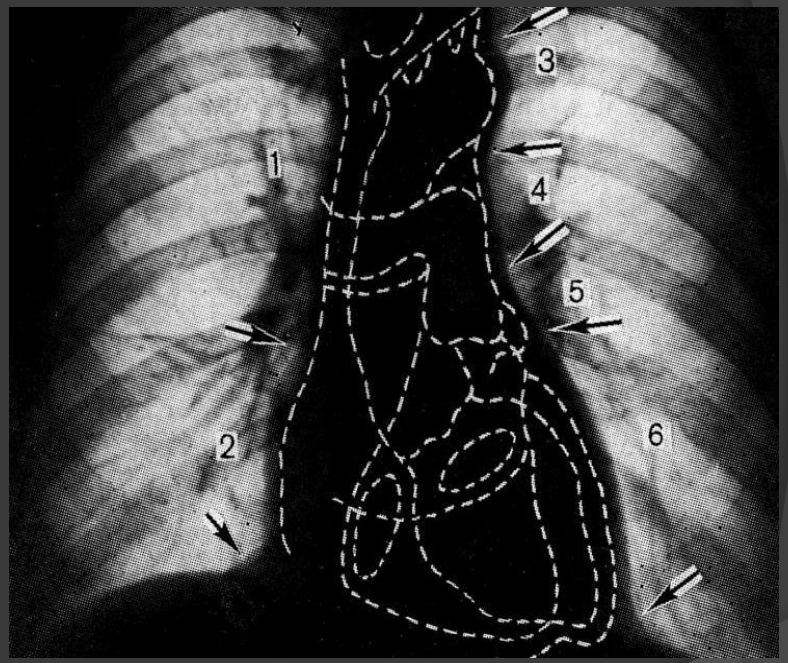
- Barium sulfate - per os
- 3 standard projections - straight, right (first) oblique, left (second) oblique
- Optional - left lateral projection

X-ray silhouette of the heart in frontal projection

Arcs on the right contour

1 Superior vena cava or ascending aorta

2 Right atrium



Left contour

1 Aorta

2 Pulmonary cone

3 Left atrial appendage

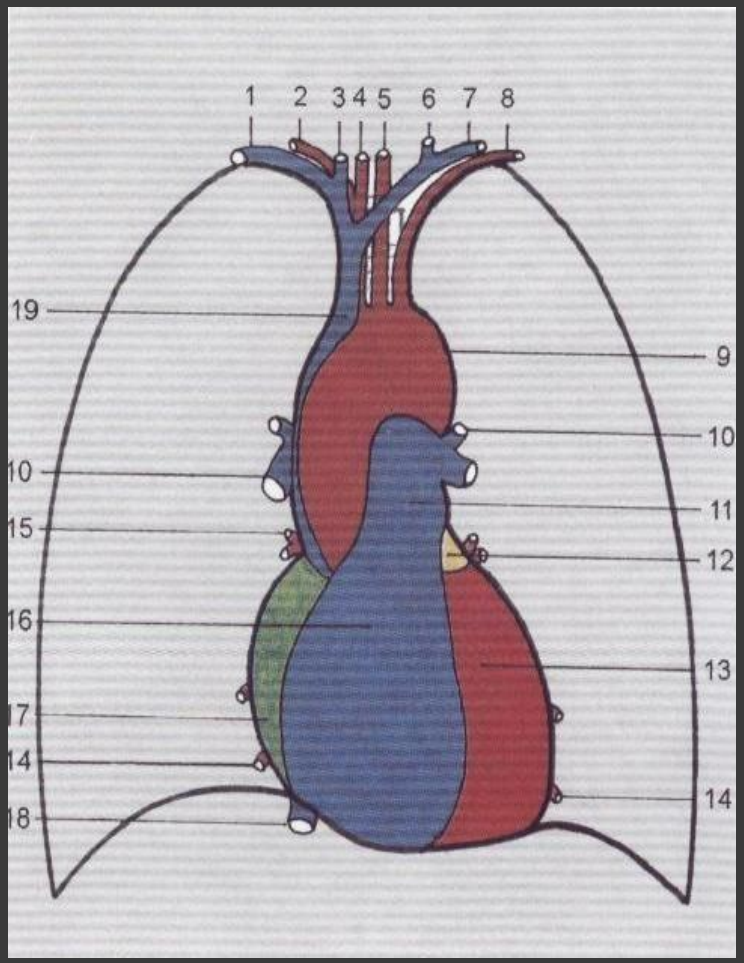
4 Left ventricle

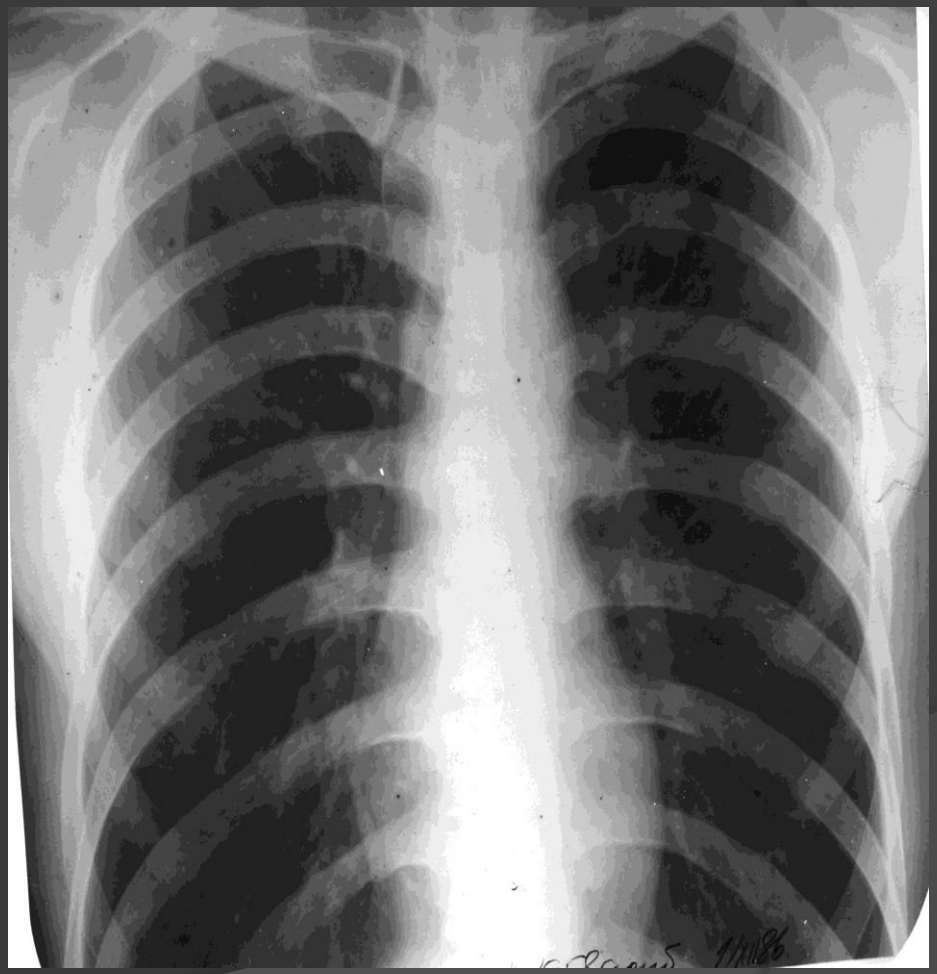
Radiographs of the heart in direct projection

- Signs of a normal heart cardiovascular shadow occupies two thirds of the height of the chest cavity
- -along the right contour, the upper (A) and lower arch (PP) are equal to each other, the atriovasal angle divides the cardiovascular shadow
- -half
- -on the left side four arcs are differentiated - as a rule, the arch of the left ventricular appendage does not normally protrude one third of the shadow of the heart in diameter lies on the right, two-thirds on the left,
- -acute cardio-diaphragm angles

X-ray examination of the heart

Diagram of the image and radiograph of the heart in direct projection

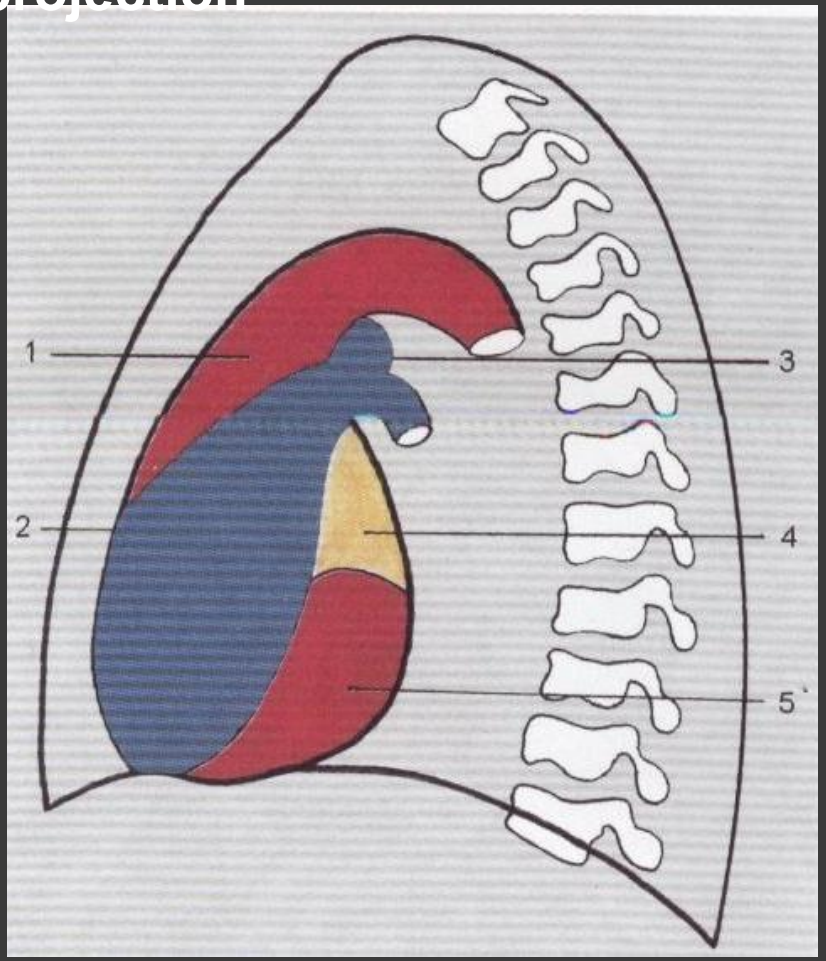




Left 4 arcs - aorta, pulmonary cone, left atrial appendage, leftventricle, on the right 2 arcs - right atrium, aorta

X-ray examination of the heart

Diagram of the image and radiograph of the heart in the left lateral projection



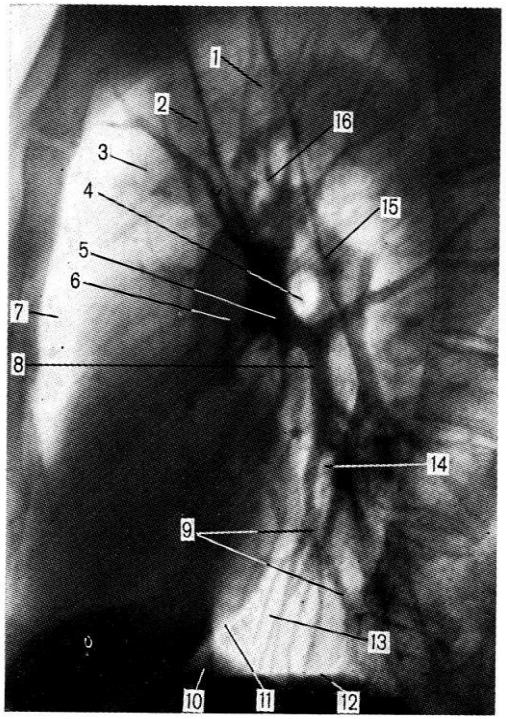


Рис. 13. Левая боковая рентгенограмма груди.

1 — трахея; 2 — дуга аорты; 3 — восходящая часть аорты; 4 — левый верхнедолевой бронх; 5 — левая верхняя легочная вена; 6 —ортоградная проекция правой легочной артерии; 7 — ретростернальное поле; 8 — нижняя левая легочная вена; 9 — правая нижняя легочная вена; 10 — нижняя полая вена; 11 — левый желудочек; 12 — левый купол диафрагмы; 13 — ретрокардиальное поле; 14 — дистальная часть правой легочной артерии; 15 — левая легочная артерия; 16 — главный бронх.

To assess the size of the right and left ventricle - their ratio is 1: 1

Radiograph of the heart in the right oblique projection - the posterior contour is formed by the atria (left at the top), the anterior contour by the ventricles (right at the top - conus pulmonalis)

Signs of the norm-Cardiovascular shadow is rectangular in shape triangle

- between the posterior contour of the heart and the shadow of the spine, rectangular enlightenment
- - the anterior contour of the heart is not reaches the chest wall, including in the area of the left ventricular arch
- - no significant swelling of individual chambers and vessels
- - the contrasting esophagus is not deviates

Radiograph of the heart in the left oblique projection – the right parts of the heart are located ant eriorly, the left ones are posteriorly, above are the atria, below are the ventricles

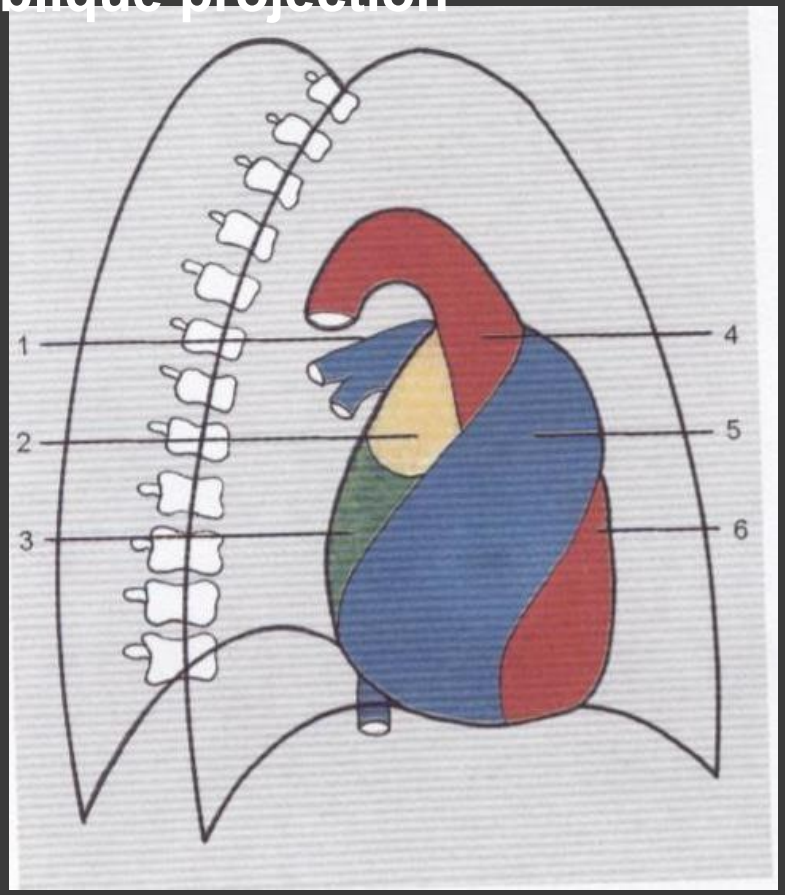
Signs of the norm

-between the posterior contour of the left atrium and the shadow spine enlightenment triangular shape

- the anterior contour of the heart is not reaches the chest wall, including in the area of the arch of the right ventricle
- - no significant bulging separate departments and vessels

X-ray examination of the heart

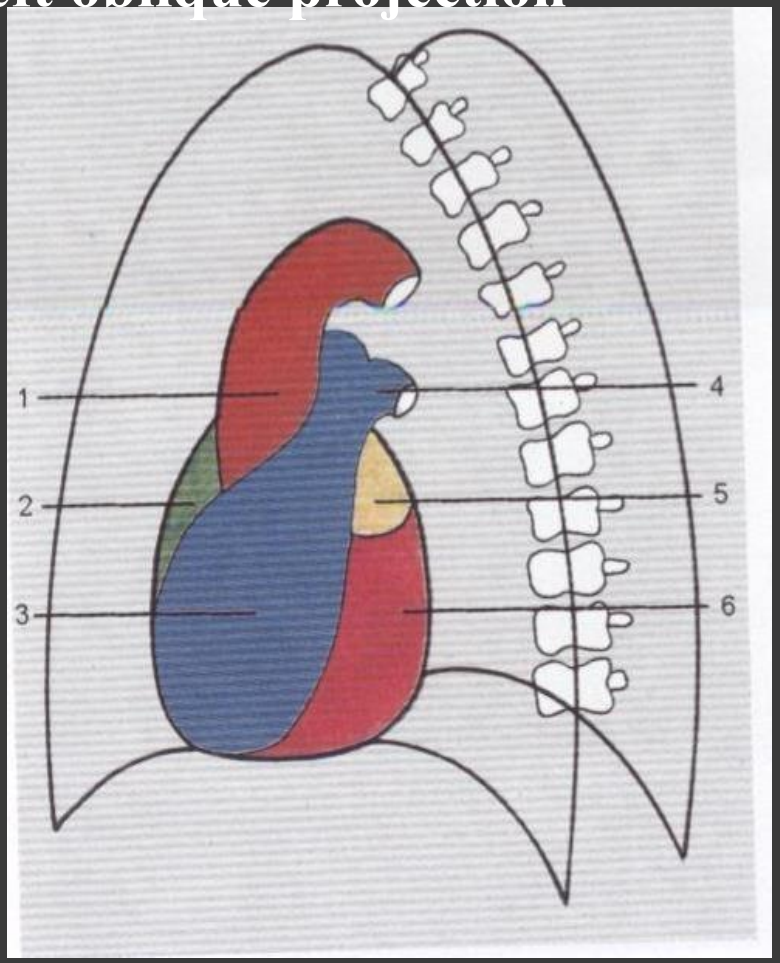
Diagram of the image and radiograph of the heart in the right oblique projection



the posterior contour is formed by the atria (left top), the anterior contourventricles (right above - conus pulmonalis)

X-ray examination of the heart

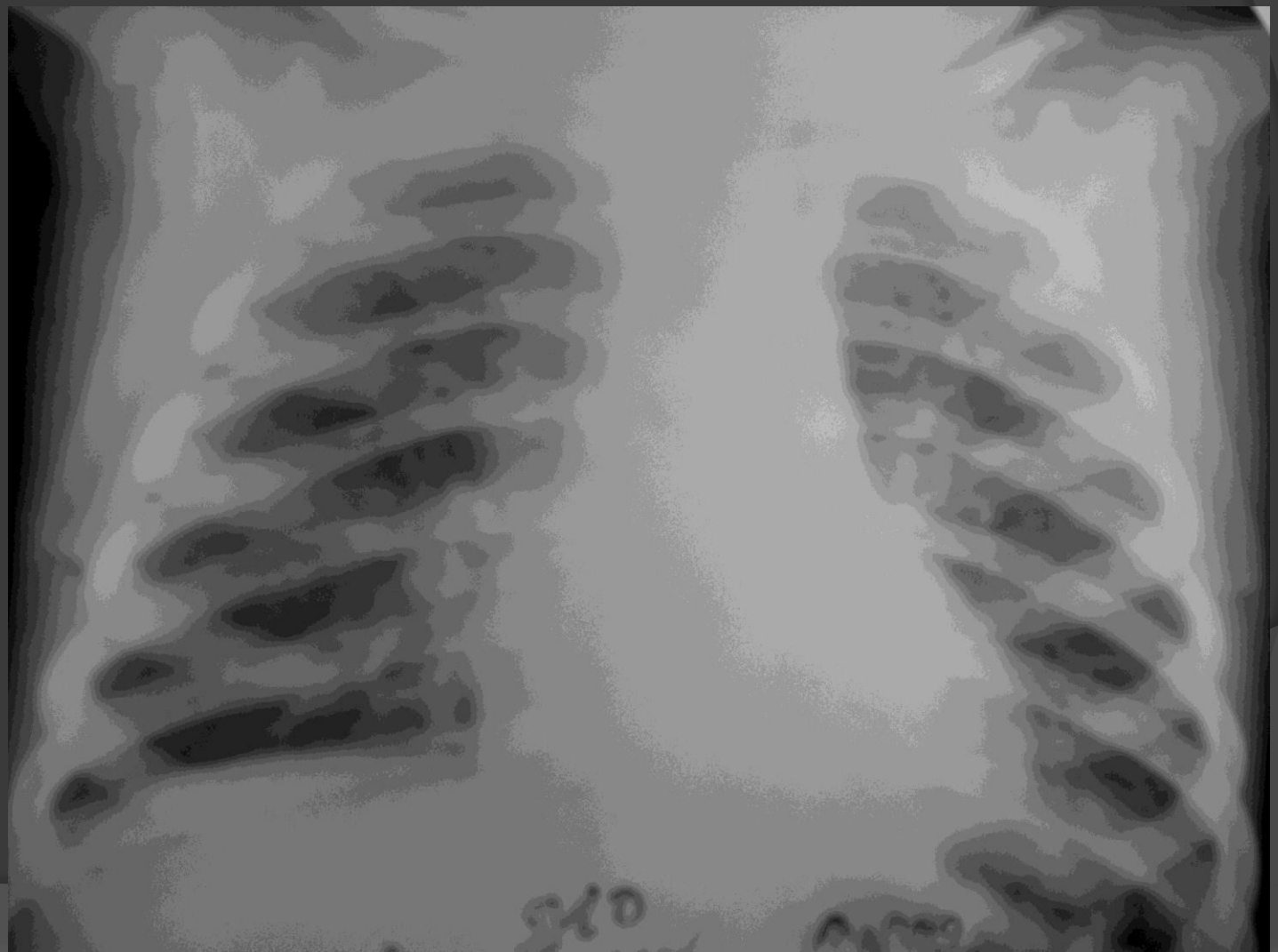
Diagram of t he image and radiograph of the heart in the left oblique projection



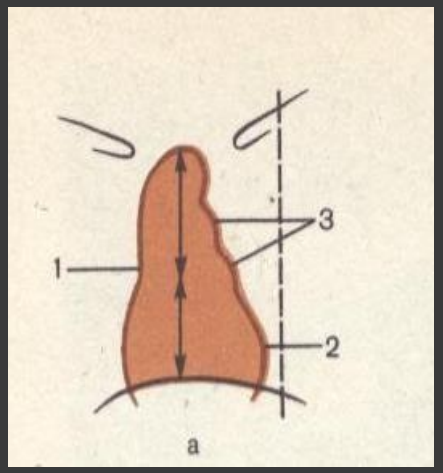
the right heart is located anteriorly, the left is posterior

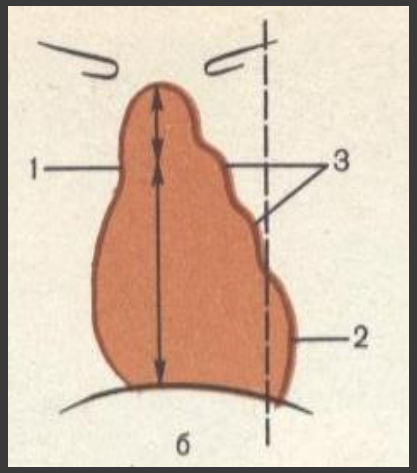
above - atria, below - ventricles

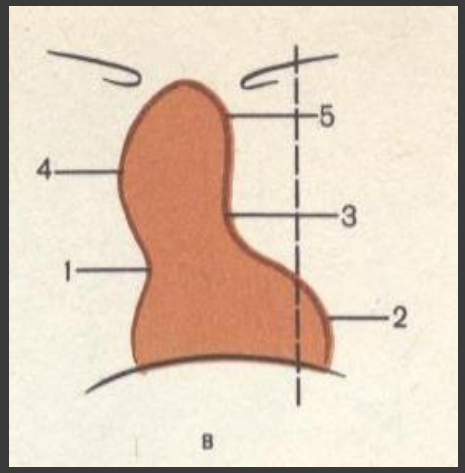
Heart in childhood x-ray of a 4-year-old child



Various forms of cardiovascular shadow - normal, mitral configuration, aortic configuration, trapezoidal shadow







Radiation methods of research of the heart

First choice methods

-**Echocardiography with doppler** echocardiography(CDM, energy and tissue DG)

-**Doppler ultrasound** - measurement of blood flow velocity using ultrasound based on the Doppler effect.

-**Doppler effect** - a physical phenomenon, according to which the frequency the perception of a sound emitted by a moving object changes when it is perceived by a stationary object

Features of radiation examination of the heart

1. 1.The heart is examined together with the pulmonary circulation -hemodynamic research principle
2. 2. Study of heart function is mandatory
3. 3. Study of blood flow is mandatory
4. 4. the heart is examined with contrasting the esophagus

The state of the pulmonary circulation can be examined on a plain chest x-ray Plain radiography and detailed ultrasound are sufficient to make a diagnosis in most medical situations

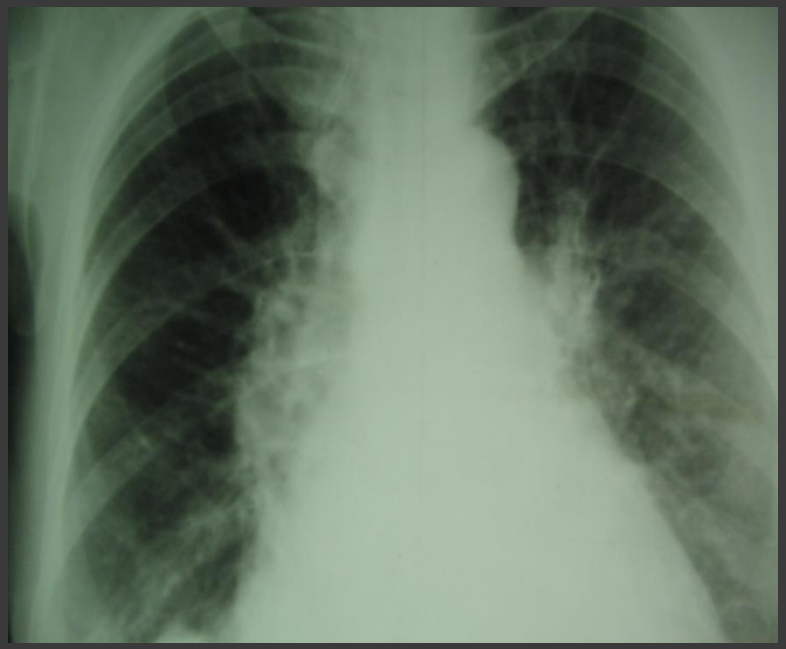
Left atrioventricular foramen stenosis (mitral stenosis)

- Smoothness of the waist of the heart
- Bulging of 3 arcs along the left contour of the heart
- In oblique projections, the contrasted esophagus is deflected by the left atrium along a small radius
- Atriomegaly
- In some cases, calcification of the leaflets of the mitral valve is visible
- Enlargement of the right ventricle and right atrium
- The shadow of the heart is enlarged in diameter, sometimes to the left, if the enlarged right ventricle becomes edge-forming, and the unchanged left ventricle rotates posteriorly
- Signs of venous stasis are especially pronounced with

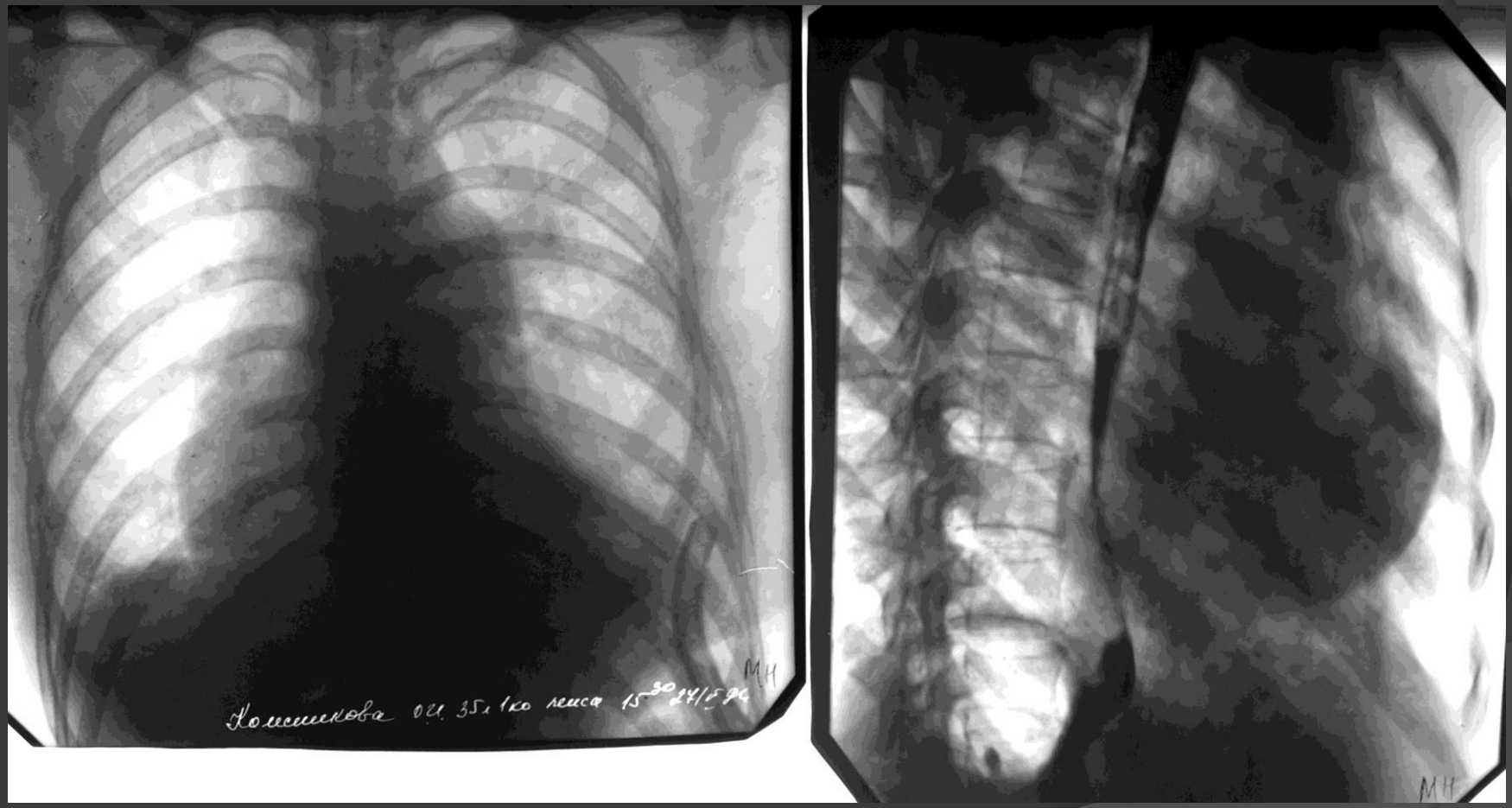
Insufficiency of the mitral valve (mitral regurgitation)

- Left atrial enlargement
- Deviation of the contrasted esophagus along an arc of a large radius (more6 cm)
- The waist of the heart is smoothed, the 3rd arch bulges (enlarged left atrium)
- Increased left ventricular arch - signs of its hypertrophy and dilatation
- In the presence of hemodynamic disorders, increased vascular, and in further and interstitial component of the pulmonary pattern
- With prolonged pulmonary hypertension - an increase in the right heart
- Difference from mitral stenosis - the pulmonary cone of the right ventricle and the arch of the pulmonary trunk bulge weakly

Mitral heart disease - mitral valve insufficiency

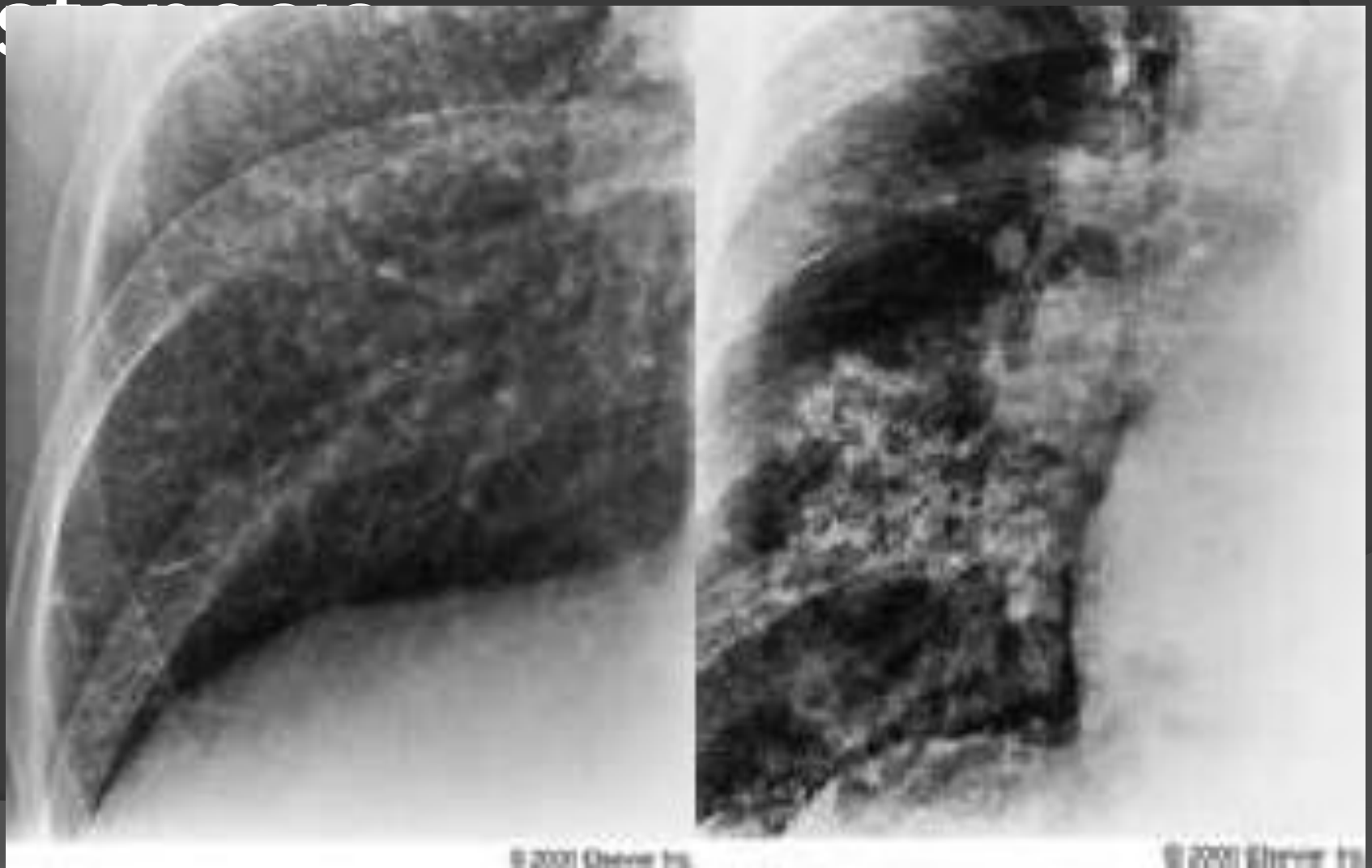


Mitral insufficiency

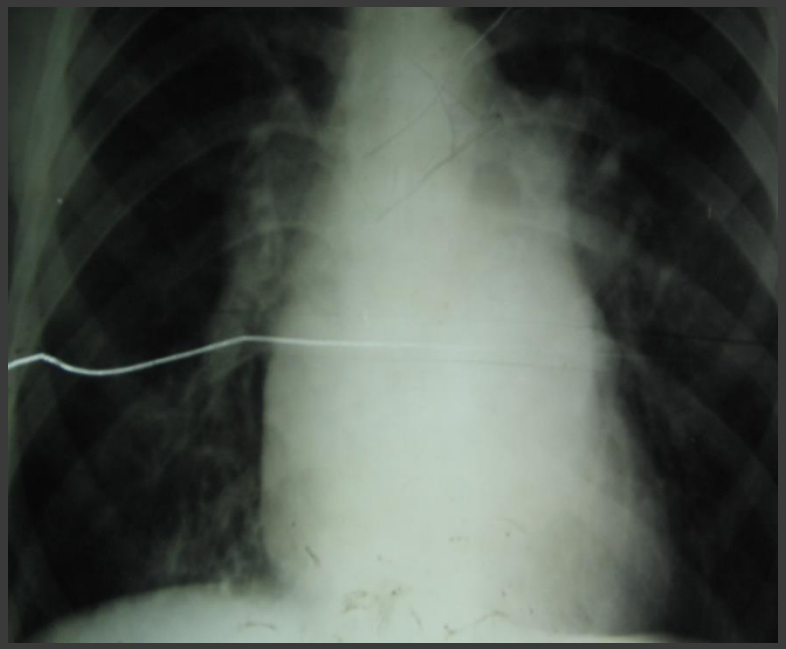


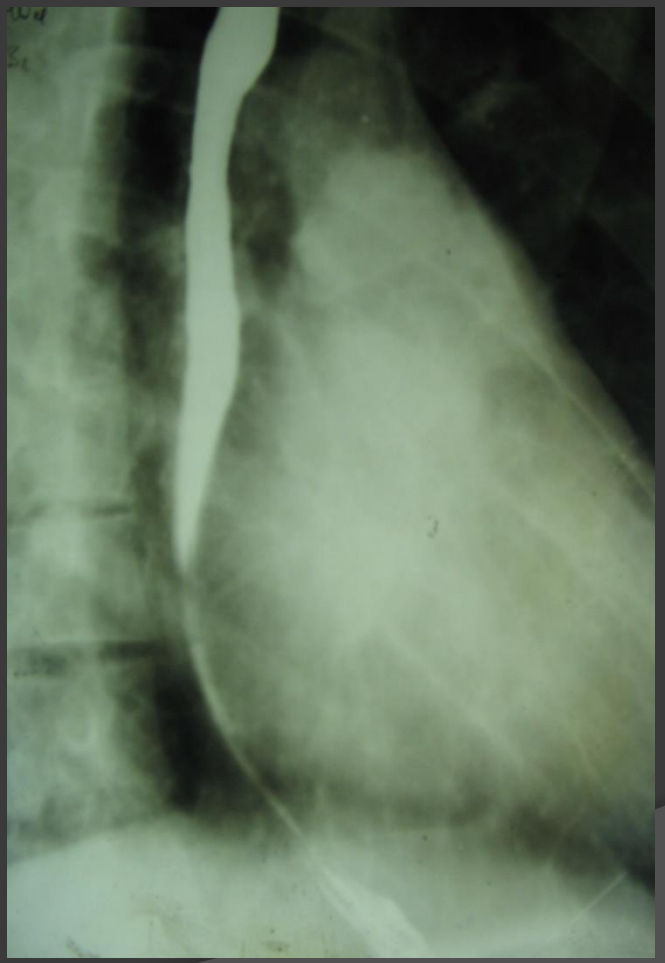
Mitral stenosis

Hemosiderosis with mitral stenosis



Mitral stenosis





Echocardiography

- Subtle morphological features of the structure of the endocardium
- Valve function
- Myocardial thickness, dimensions of heart cavities
- Myocardial contractile function
- Blood flow

Ultrasound examination of the heart

Standard projections for ultrasound imaging

-Parasternal

-Subcostal

-Apical

-Suprasternal

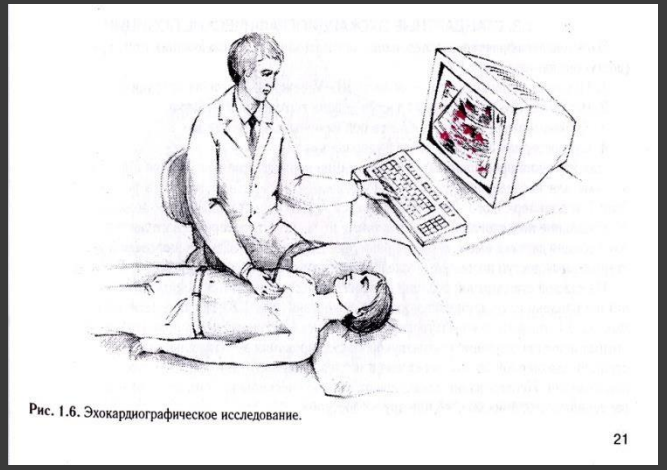


Рис. 1.6. Эхокардиографическое исследование.

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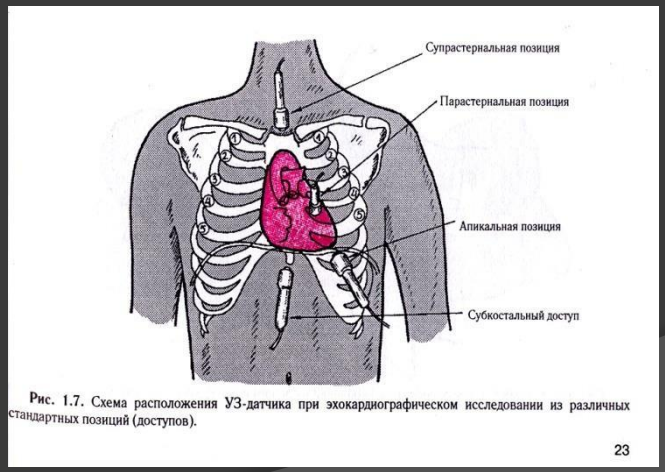

Рис. 1.7. Схема расположения УЗ-датчика при эхокардиографическом исследовании из различных стандартных позиций (доступов).

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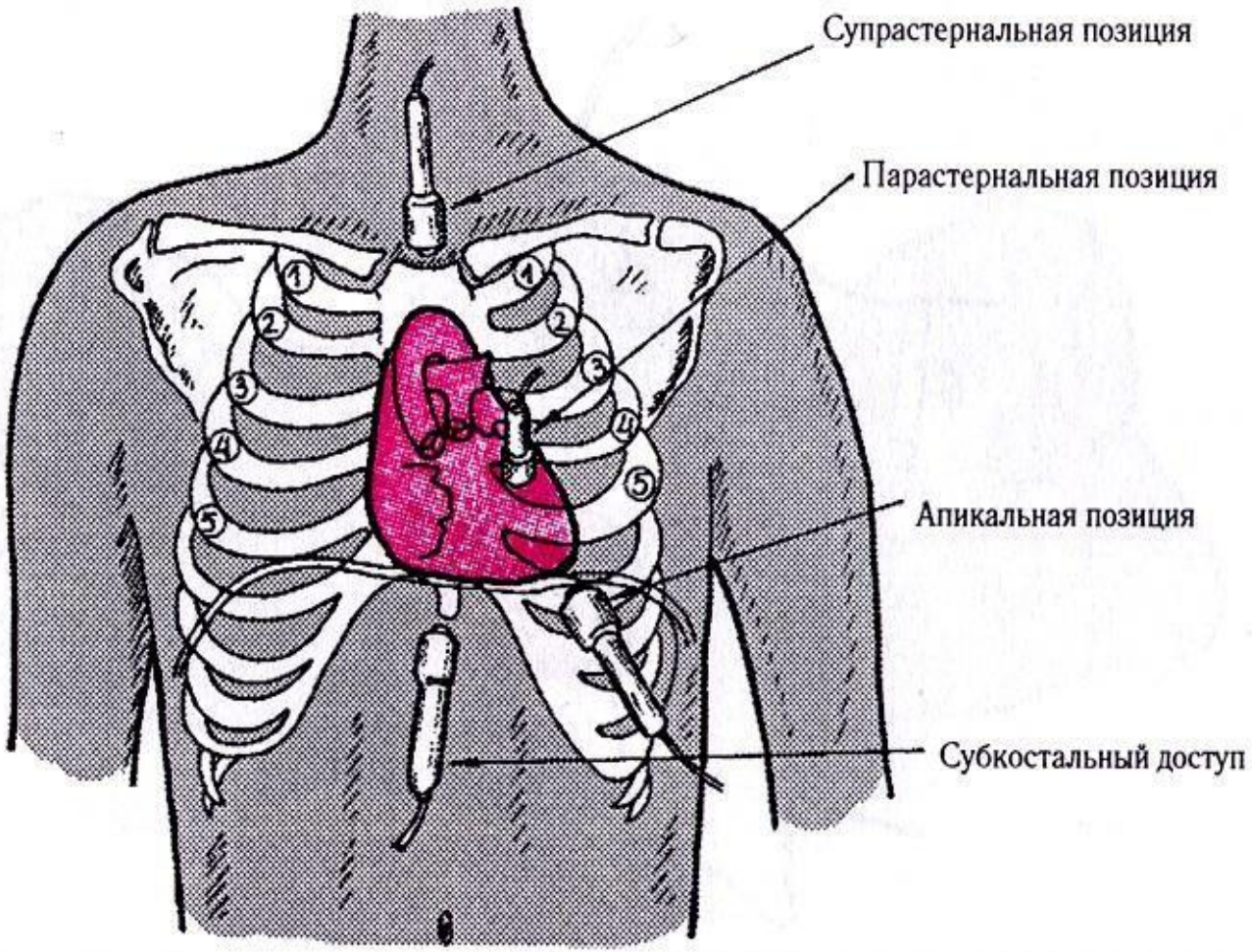

Рис. 1.7. Схема расположения УЗ-датчика при эхокардиографическом исследовании из различных стандартных позиций (доступов).

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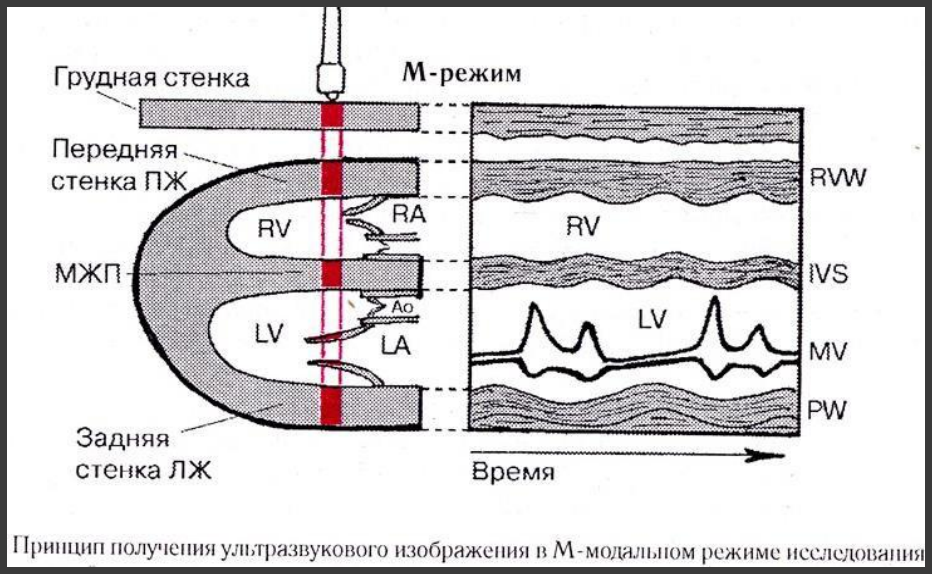
Principle of image acquisition in M-mode



Принцип получения ультразвукового изображения в М-модальном режиме исследования

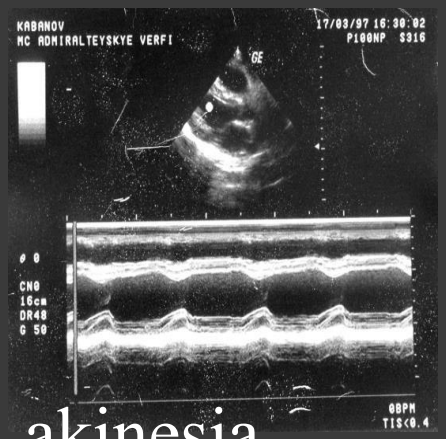
Ultrasound examination is carried out in standard positions
The ability to obtain all the necessary standard positions and analyze them forms the basis of knowledge echocardiography
The study is carried out in one-dimensional mode, two-dimensional mode and using dopplerography.

Echocardiography

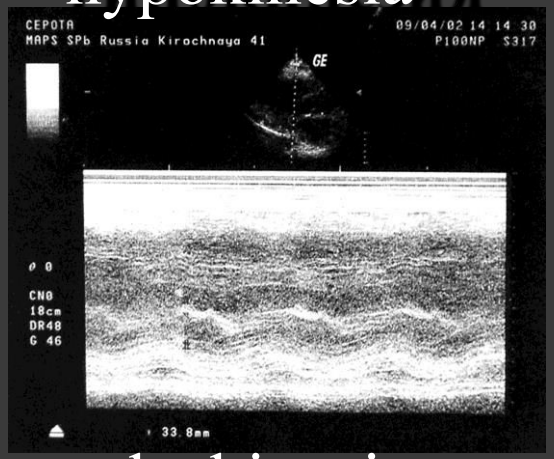
M-mode - detailed information about the dynamics of the behavior of reflecting structures located along the ultrasound beam; the form of a group of curves, each of which corresponds to certain structure

Violations of local contractility of the left ventricle

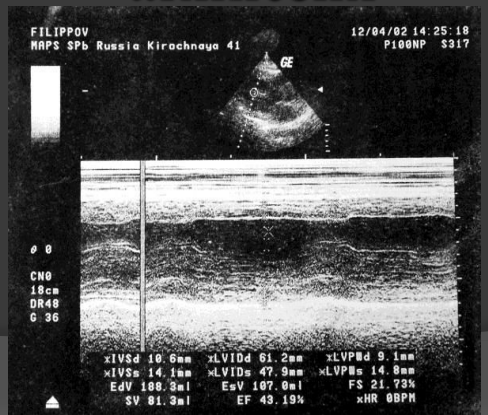
normal



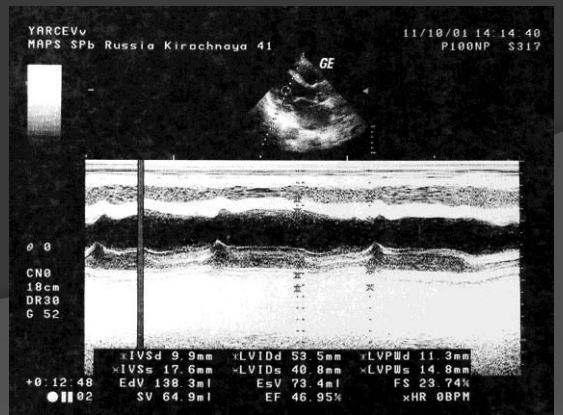
hypokinesia



akinesia



dyskinesia



Principle of acquiring an image in two-dimensional mode

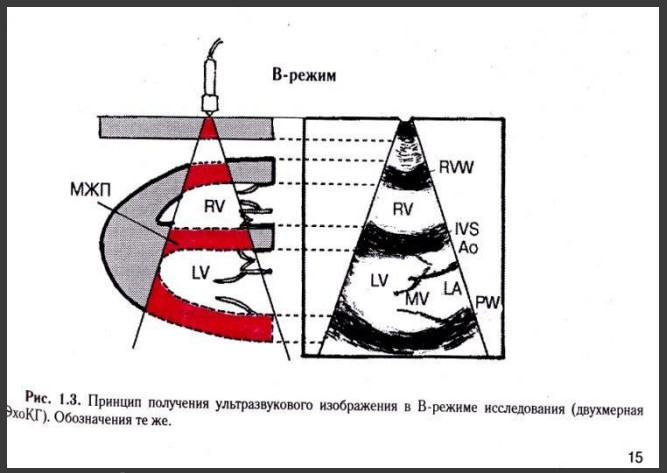


Рис. 1.3. Принцип получения ультразвукового изображения в В-режиме исследования (двухмерная ЭхоКГ). Обозначения те же.

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Sonography (B - mode) - two-dimensional examination of the heart Provides an opportunity to observe the movements of the walls of the heart and valves in real time on the display screen

In standard projections, the sensor is positioned along the long or short axis of the heart Microconvex probe, 3.5 MHz

The diagram shows a study at the level of the mitral valves. Descending sector scanning shows skin, right ventricle, interventricular wall, left ventricular cavity, mitral valve, left atrium

Sonography of the heart from the left parasternal approach along the long axis of the left ve

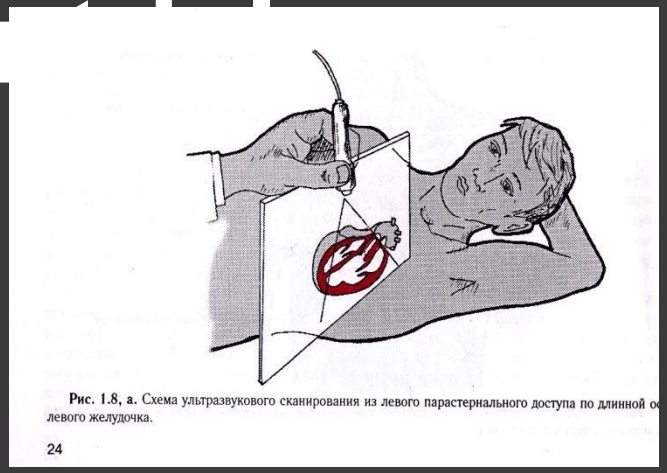

Рис. 1.8, а. Схема ультразвукового сканирования из левого парастернального доступа по длинной о
левого желудочка.

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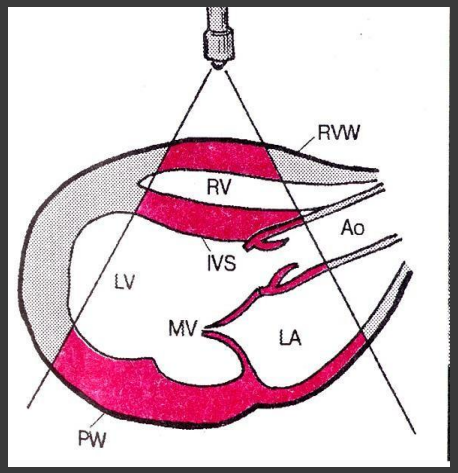
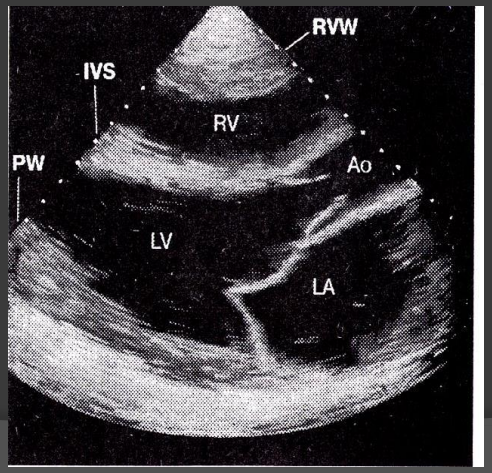




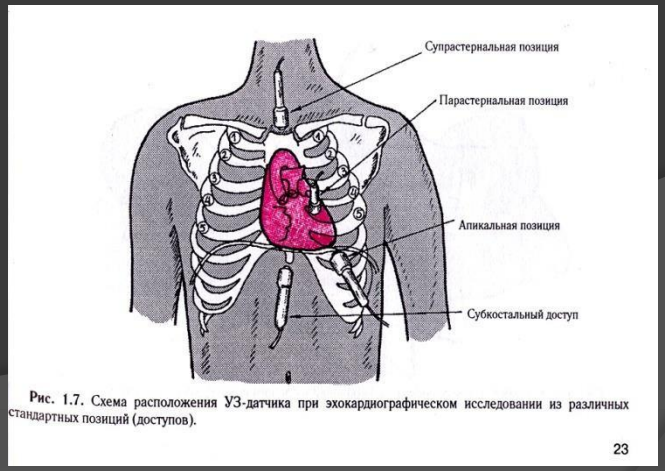


Рис. 1.7. Схема расположения УЗ-датчика при эхокардиографическом исследовании из различных стандартных позиций (доступов).

23

Parasternal access along the short axis at the level of the aortic valve

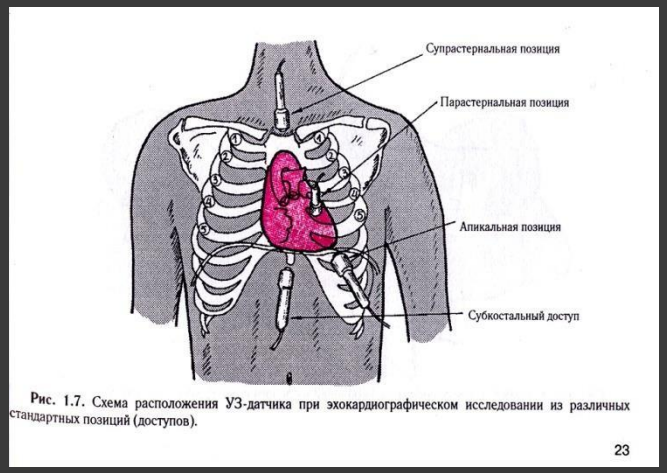


Рис. 1.7. Схема расположения УЗ-датчика при эхокардиографическом исследовании из различных стандартных позиций (доступов).

23

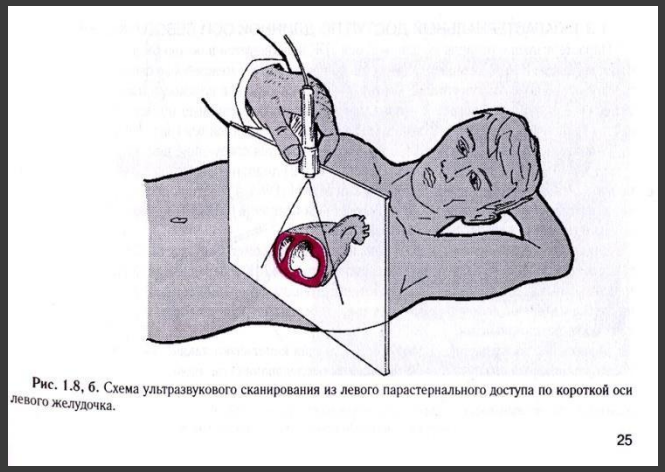
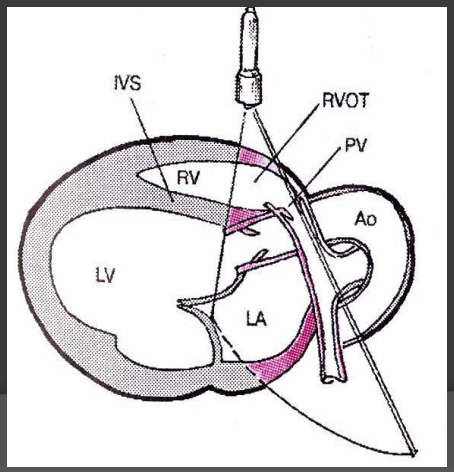
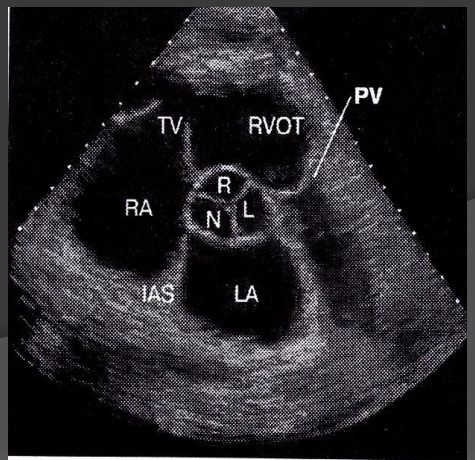


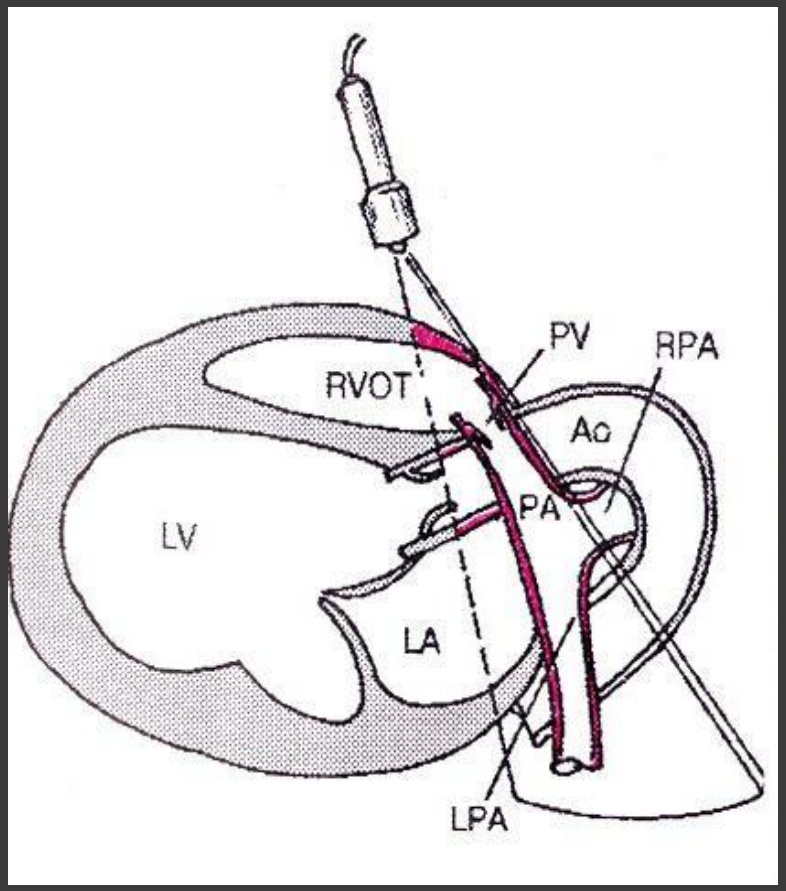
Рис. 1.8, б. Схема ультразвукового сканирования из левого парастернального доступа по короткой оси левого желудочка.

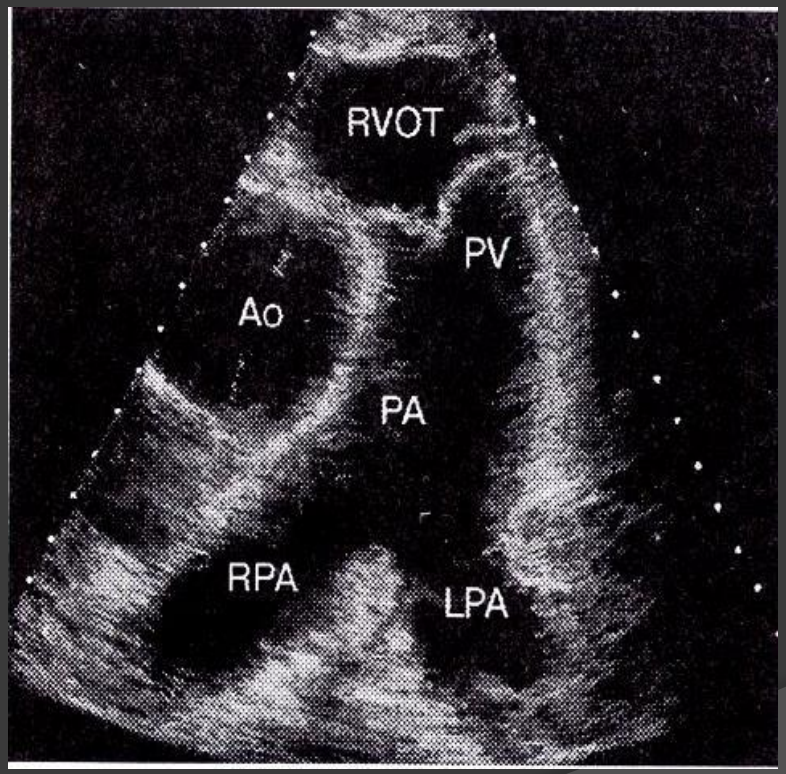
25



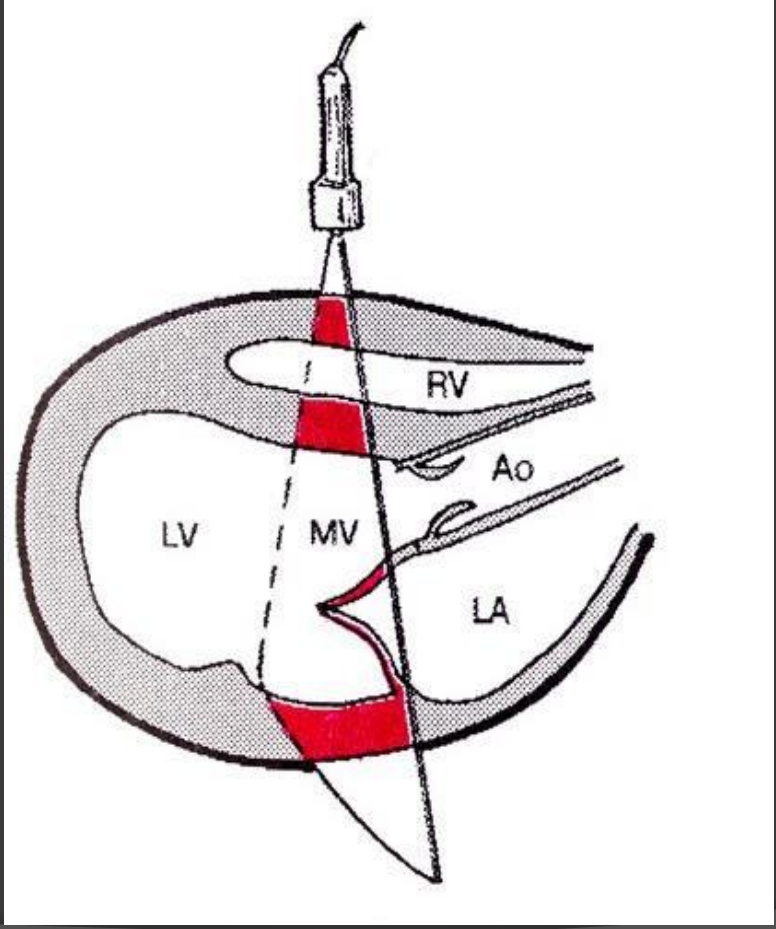


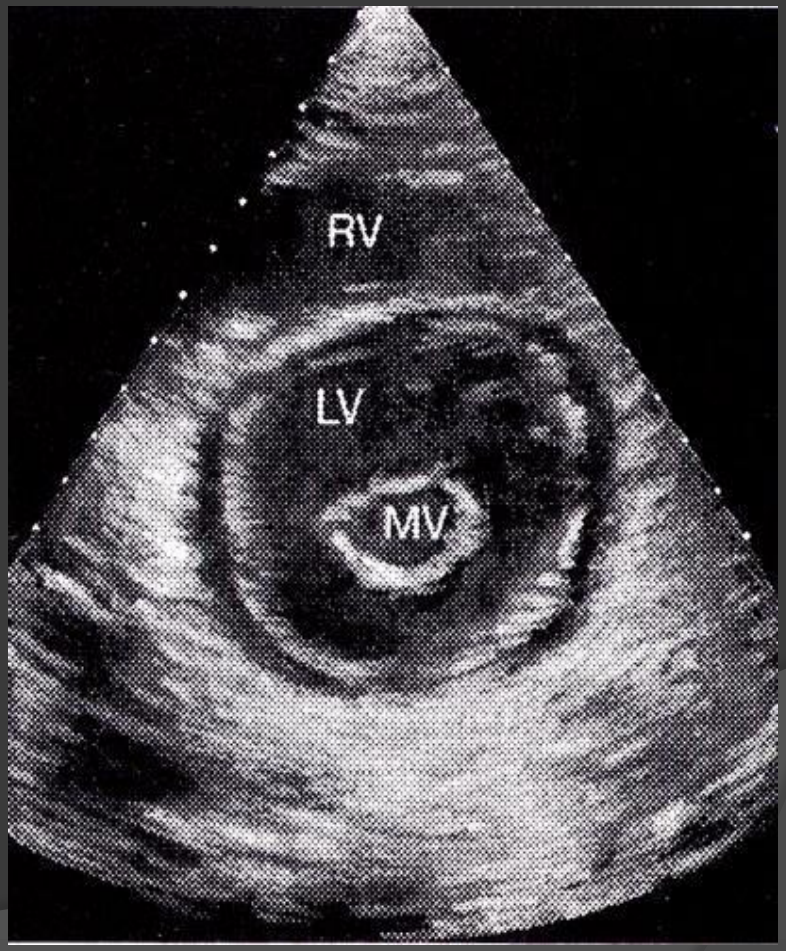
Scanning at the level of the aortic valve



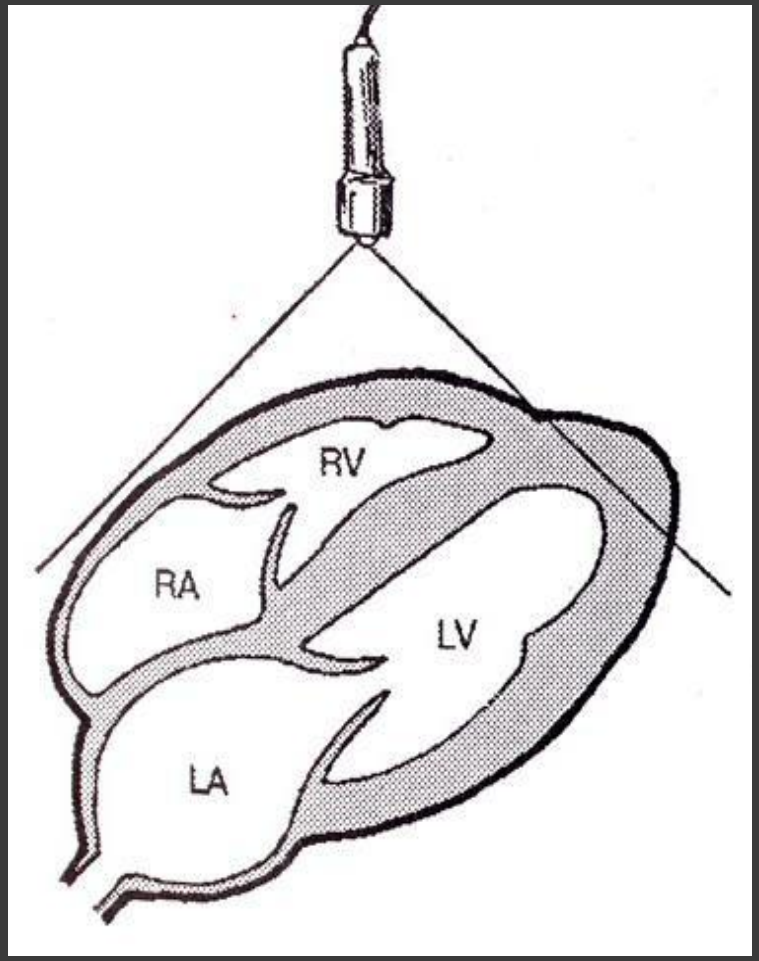


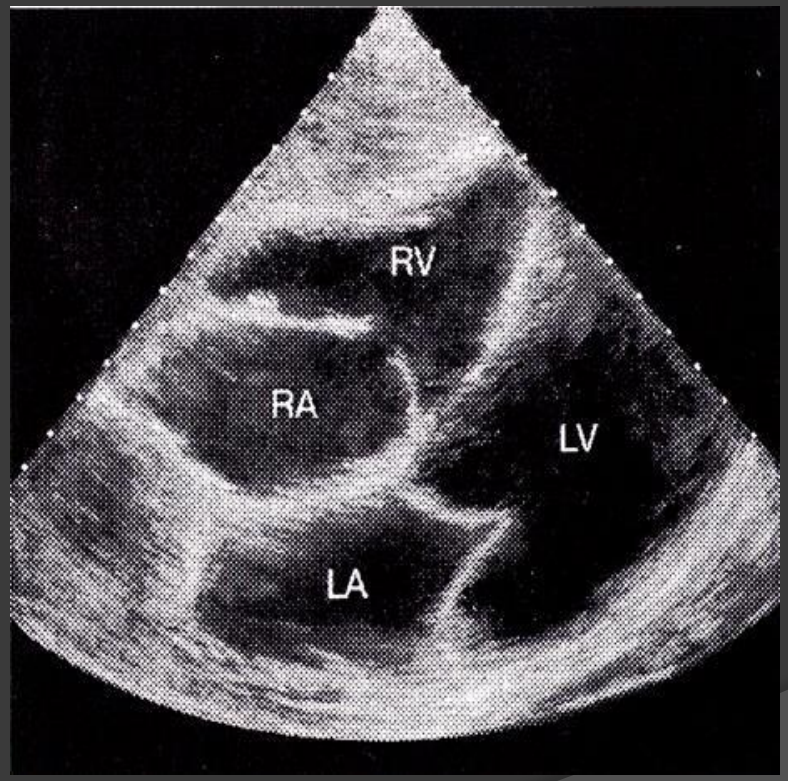
Scanning from parasternal access at the mitral level valve



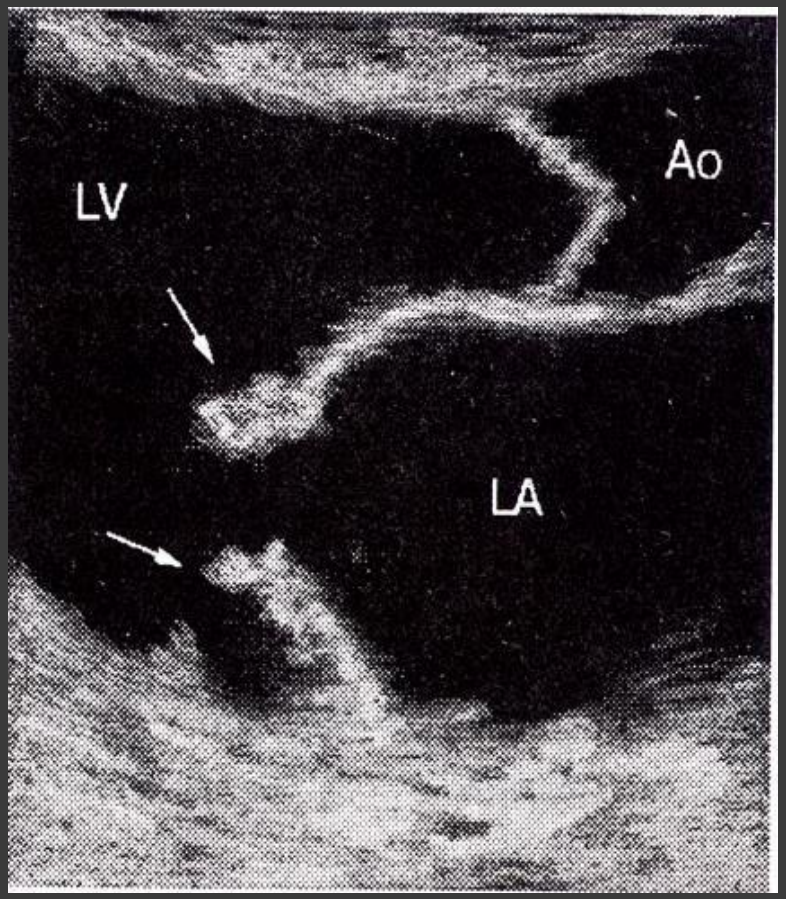


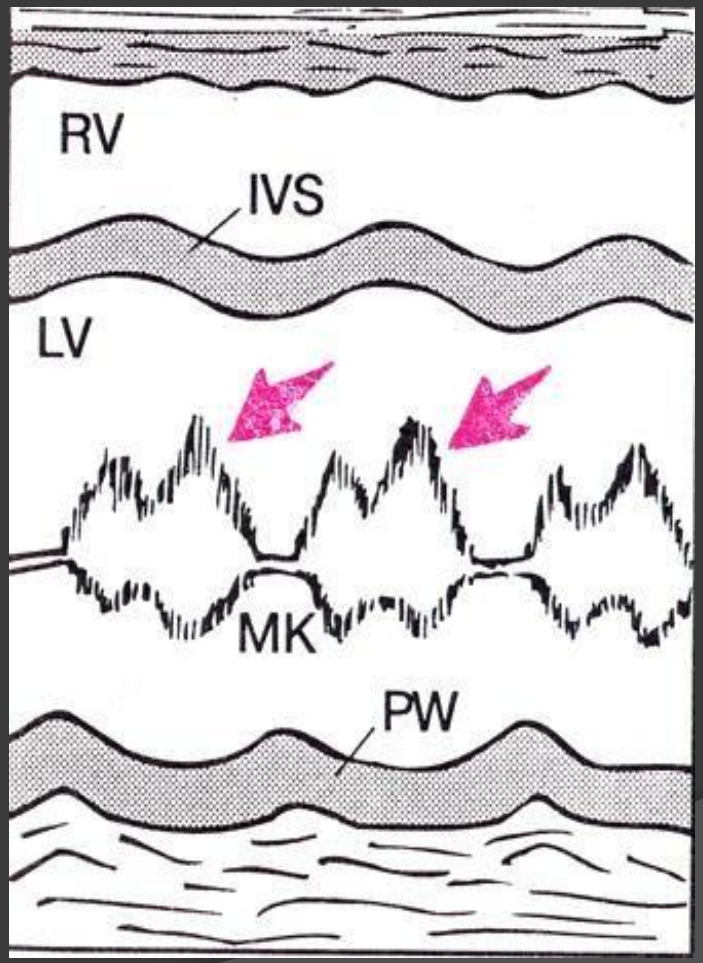
Scanning by subcostal approach along the long axis



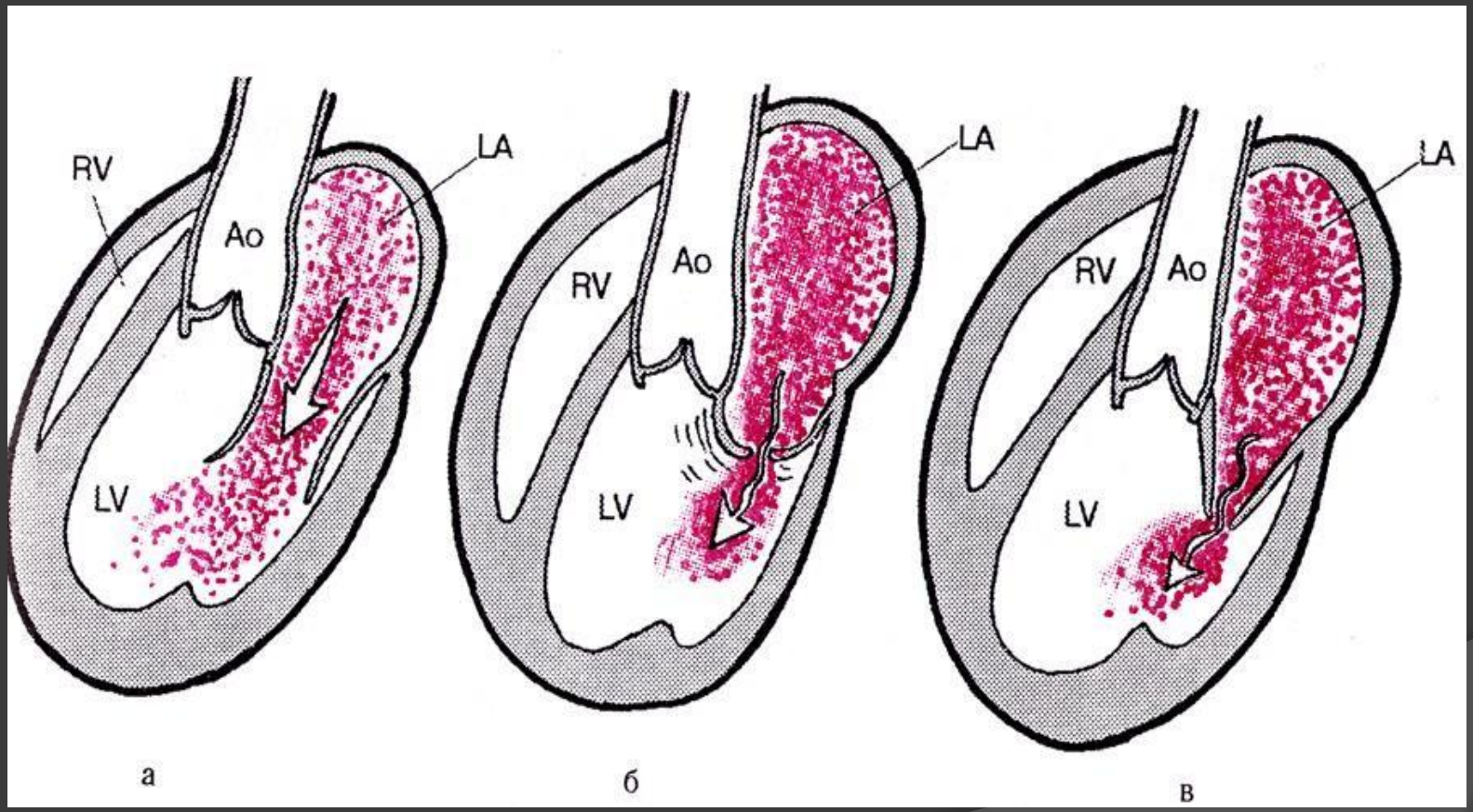


Ultrasound signs vegetations on the leaflets of the mitral valve

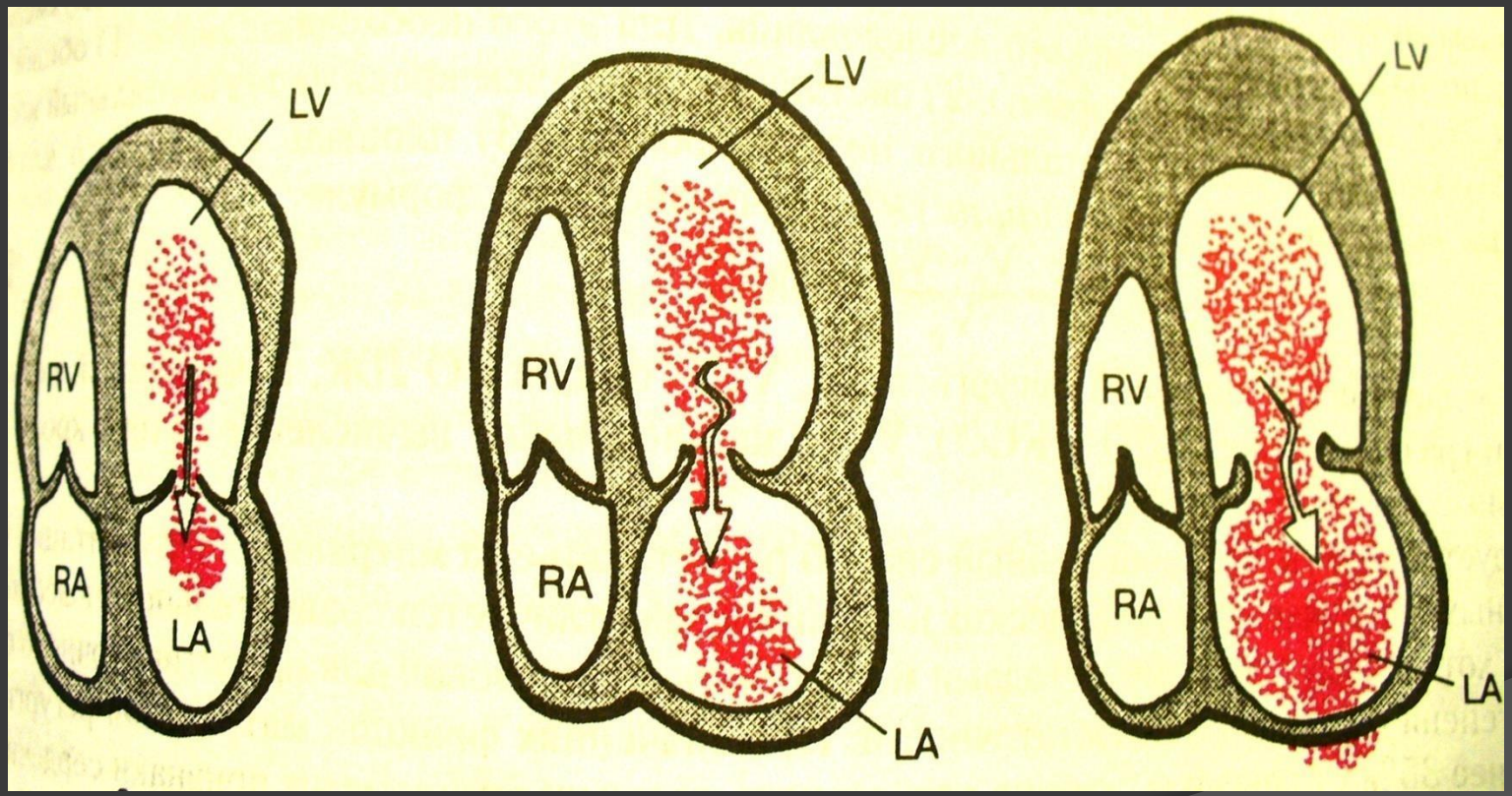




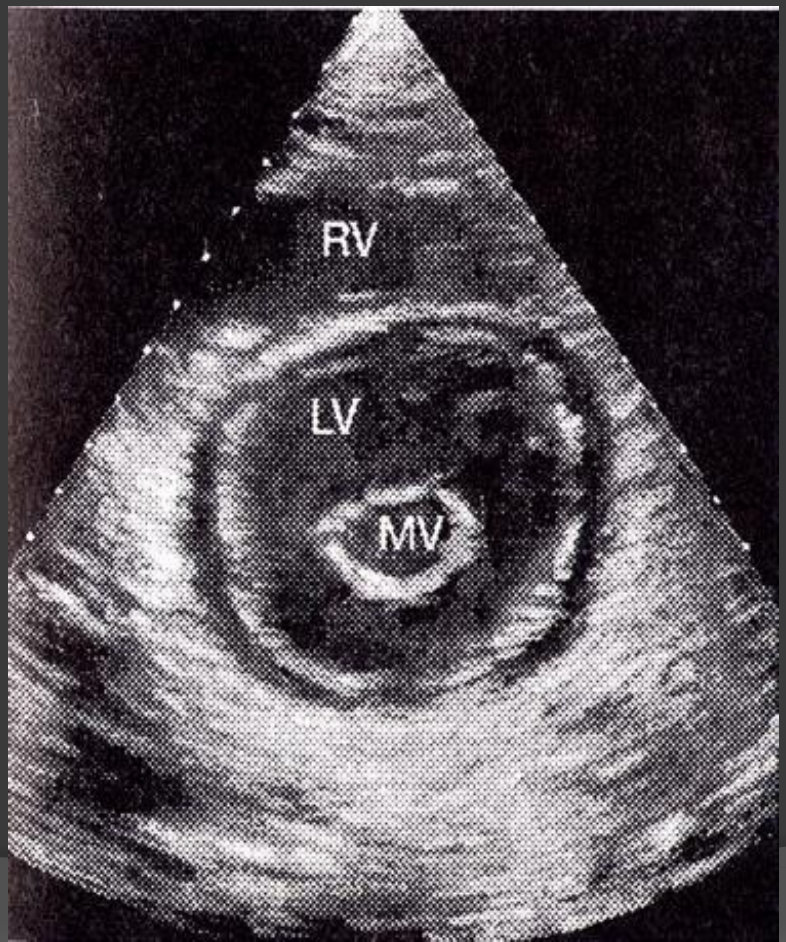
Diastolic blood flow in normal conditions and with stenosis of the mitral foramen

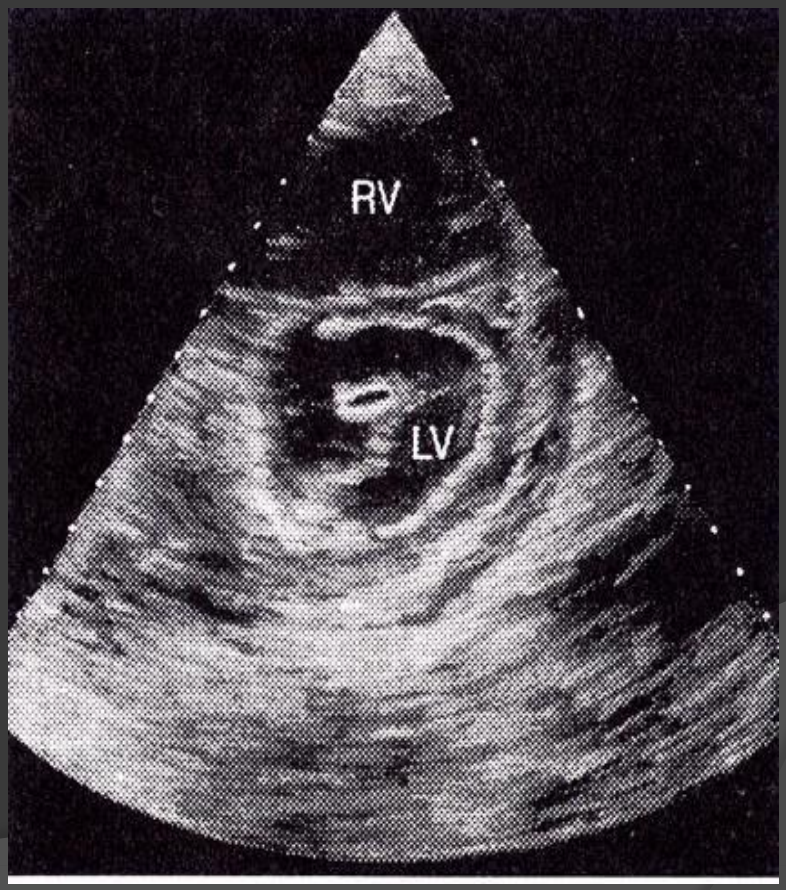


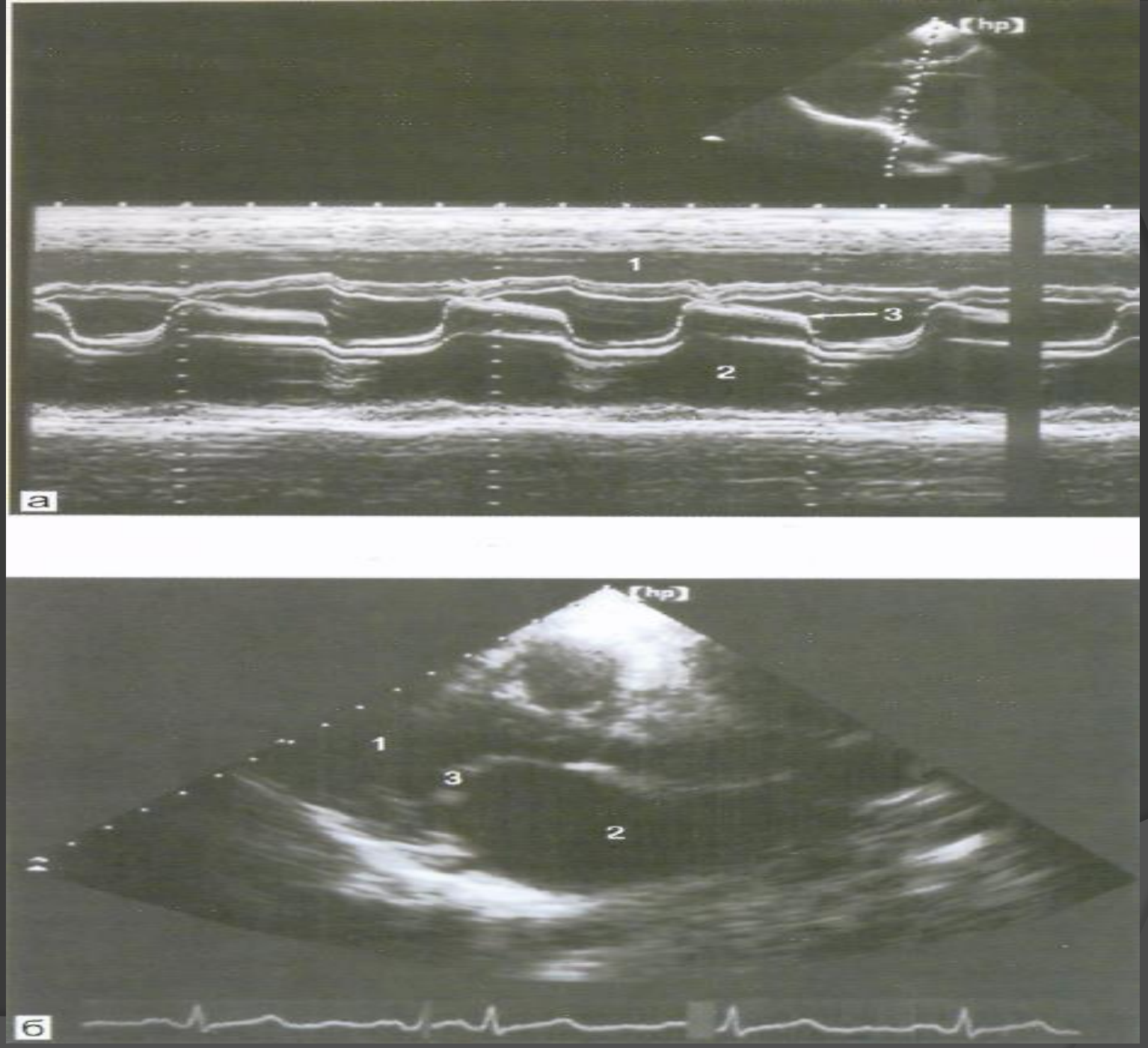
Insufficiency of the mitral valve



Reduction of diastolic opening of the mitral valve and narrowing of the mitral opening with stenosis (right), left -norm. Parasternal access along the short axis.






hp
1
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а
hp
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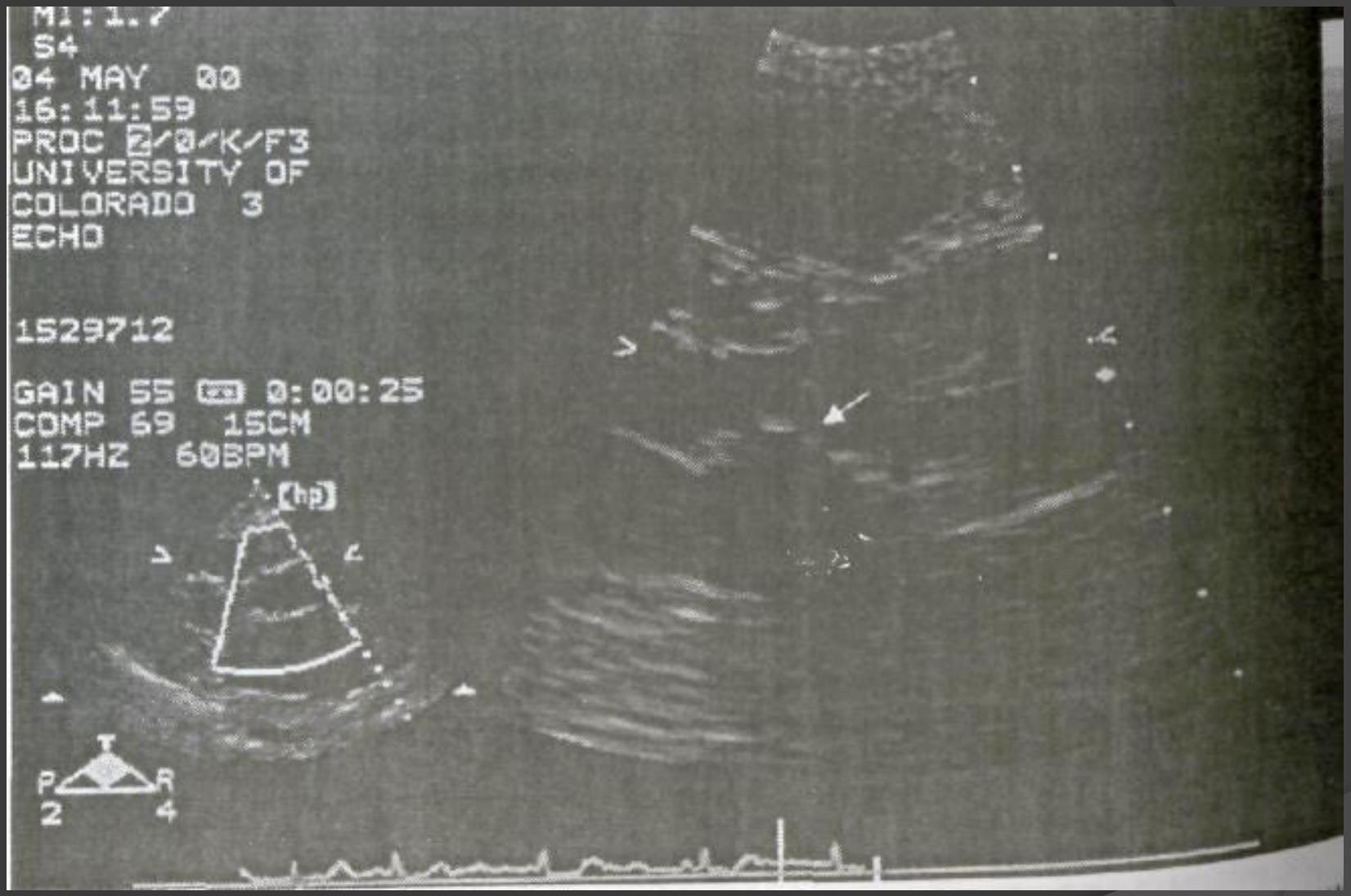
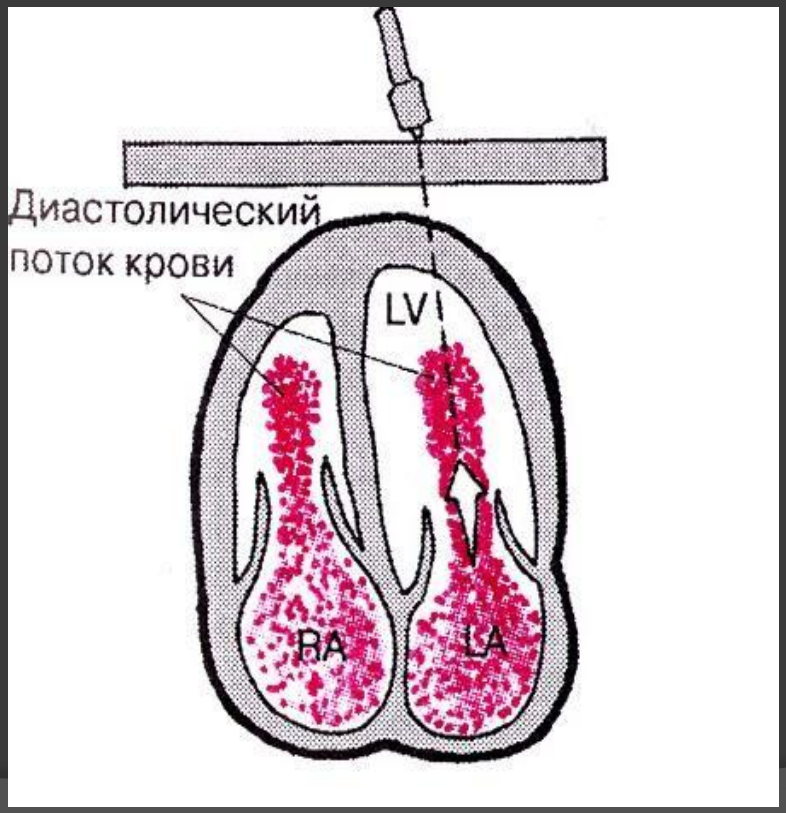
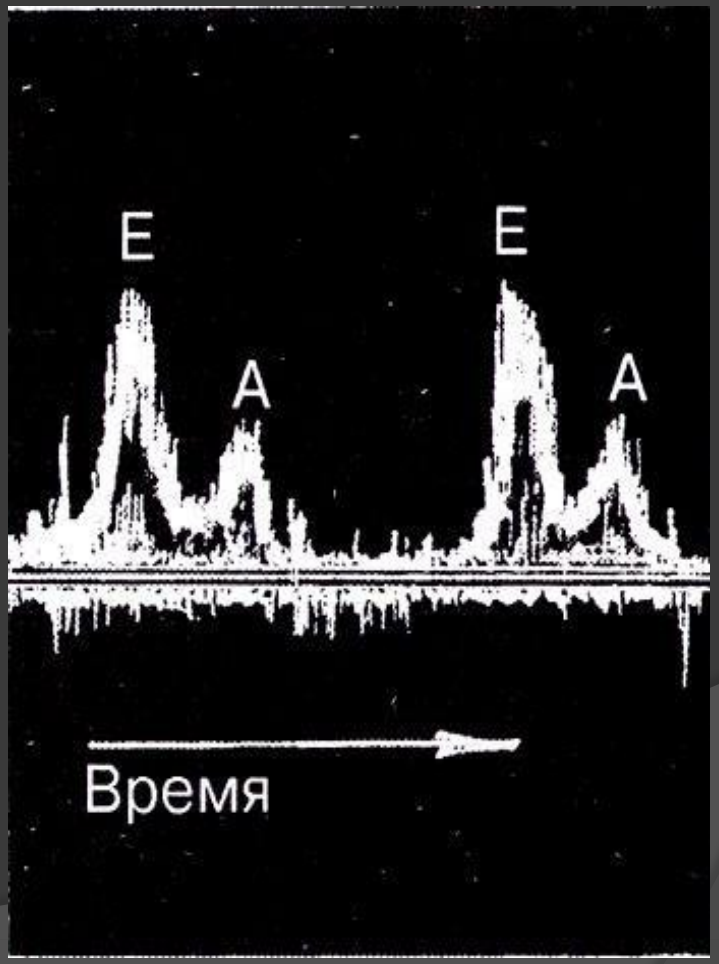
б



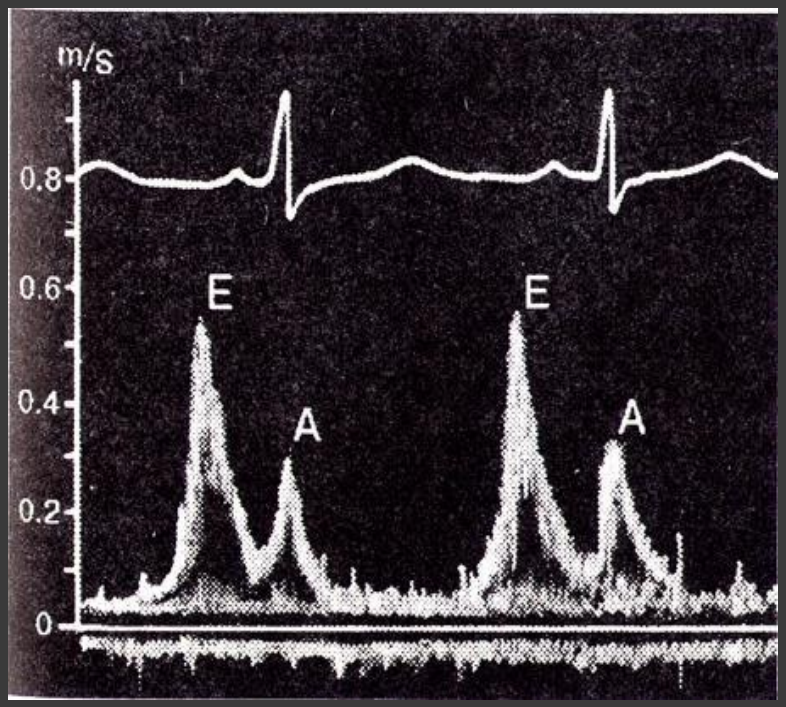
Mitral stenosis (B-mode)

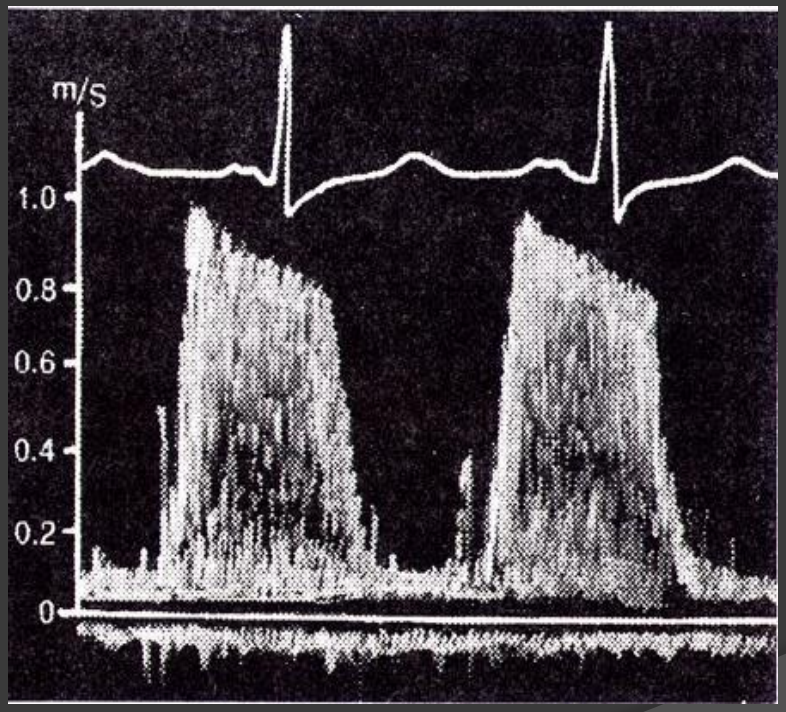
The principle of obtaining Doppler echocardiography transmitral blood flow from the apical approach. E - early peak and A - late peak left ventricular diastolic filling.



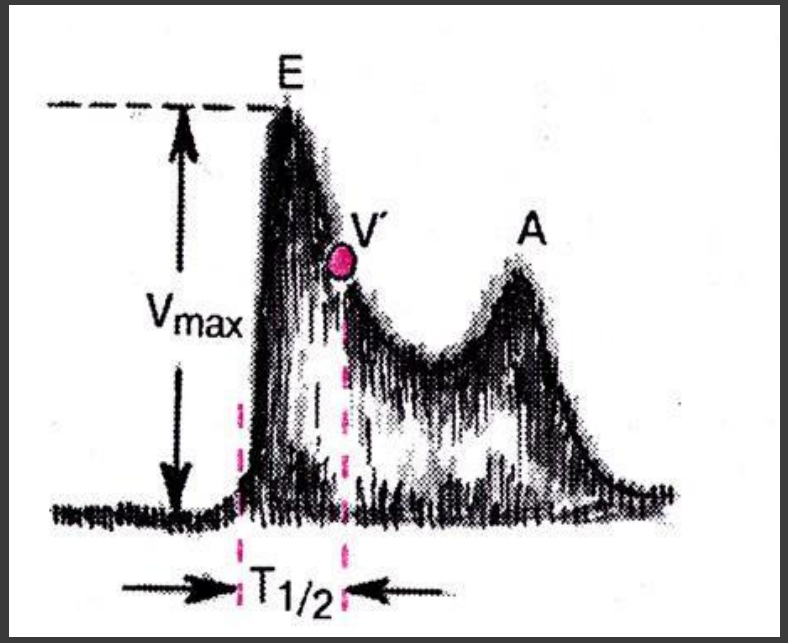


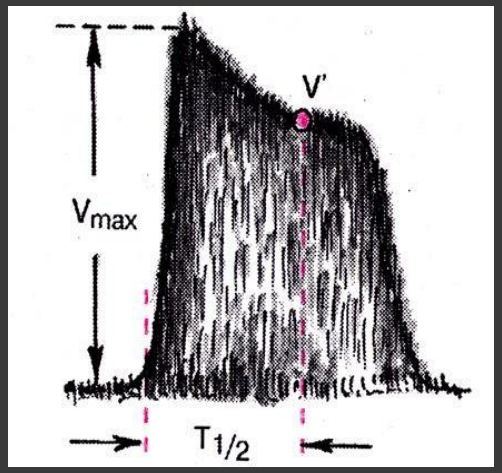
Transmitral blood flow Doppler for mitral stenosis





Quantitative assessment of blood flow velocity with Doppler ultrasonography.





а б

Рис. 4.7. Количественная оценка характера трансмитрального диастолического кровотока в норме (а) и у больного со стенозом левого атриовентрикулярного отверстия (б). Объяснение в тексте.

V_{max} – максимальная скорость кровотока (фаза быстрого наполнения), V′ – моментная линейная скорость кровотока, равная 70% от максимальной (уменьшение скорости в 1,4 раза), $T_{1/2}$ – время полуспада диастолического градиента давления (снижение градиента в 2 раза по сравнению с максимальным).

RCT, SCT Indications

- Clarification of the nature of changes in the lung tissue
- Localization of pathological education (intra-, paracardial)
- Diseases of the pericardium
- Aortic aneurysm of any location

limitations

- Ionizing radiation
- Insufficient image acquisition speed

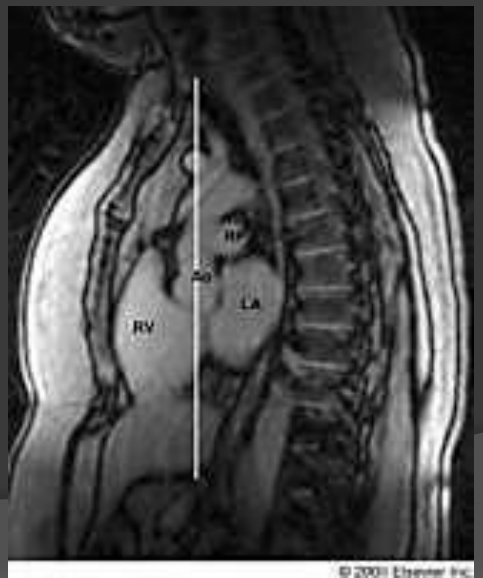
Multispiral computed tomography advantages

- Increase research speed
- Enhanced resolution
- High quality reconstructions in various planes
- CT angiography

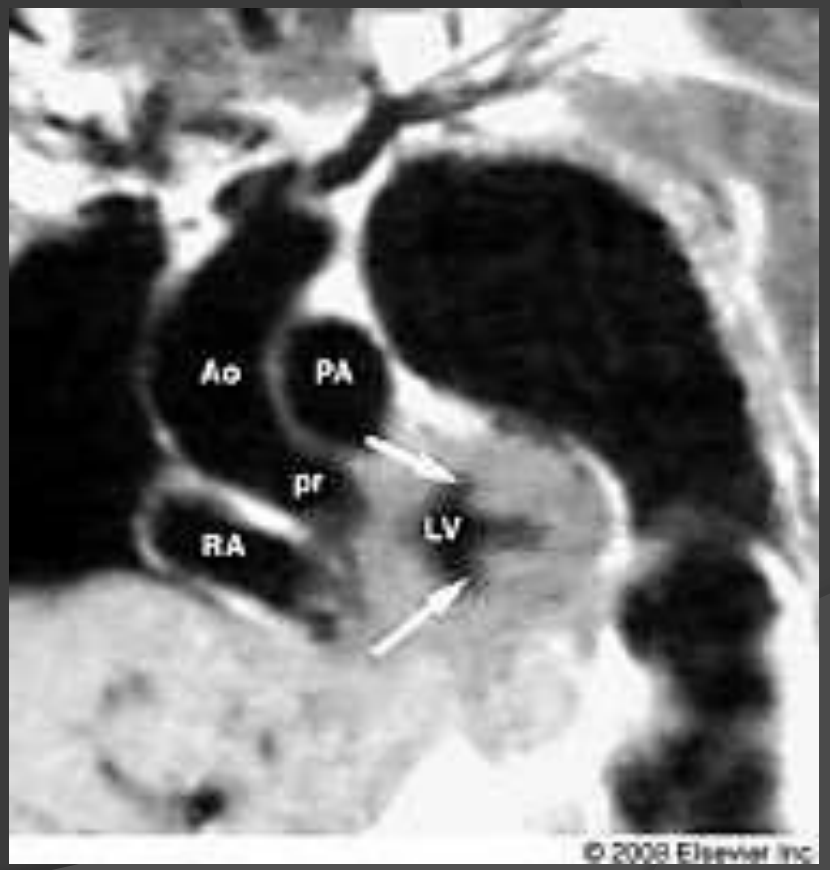
magnetic resonance imaging Indications

- Arrhythmogenic pancreatic dysplasia
- Diagnosis of heart tumors and blood clots
- Complicated CHD

Cardiometry, MRI



MRI aortic stenosis



MRI of the heart

Aortic aneurysm thrombosis

Radionuclide methods Indications

- Assessment of myocardial perfusion
- Assessment of the reserve capacity of the heart muscleEquilibrium VH
- Pumping function of the myocardium
- The nature of the movement of the walls of the heart

PET

- **Assessment of myocardial perfusion and metabolism**

Coronary angiography Indications

- Assessment of the condition of the coronary arteries
- Study of blood flows in the chambers

of the heart during

-complex CHD

-arrhythmogenic dysplasia of right ventricle

Contraindication: Contrast

MRI of the heart