JSC Astana Medical University

Department of Radiation Diagnosis and Radiation Therapy

CREATION OF RADIOGRAPHS AND SONOGRAMS FOR CARDIOVASCULAR SYSTEM

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INTRODUCTION

To study the **Heart and Large Vessels**, all known diagnostic methods are widely used:

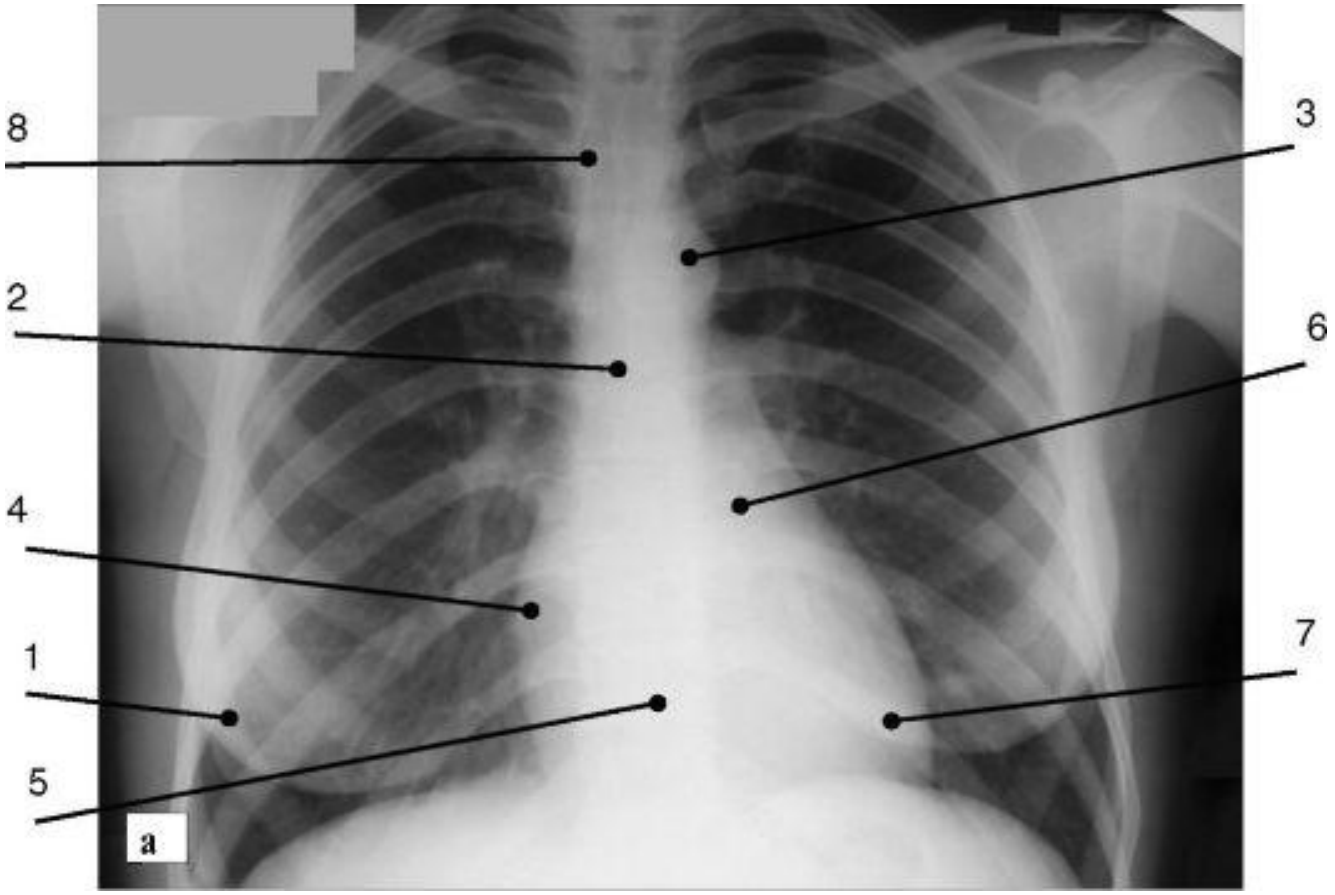
1. **Echocardiography.**
2. **Radionuclide methods.**
3. **CT**
4. **MRI**
5. **Angio and Coronaroangiography.**

Methods of radiation diagnosis can be used to study the **position, shape, size and function of the heart chambers, perfusion and viability of the myocardium, the structure of the coronary arteries and large main vessels, as well as the peculiarities of the blood flow in them.**

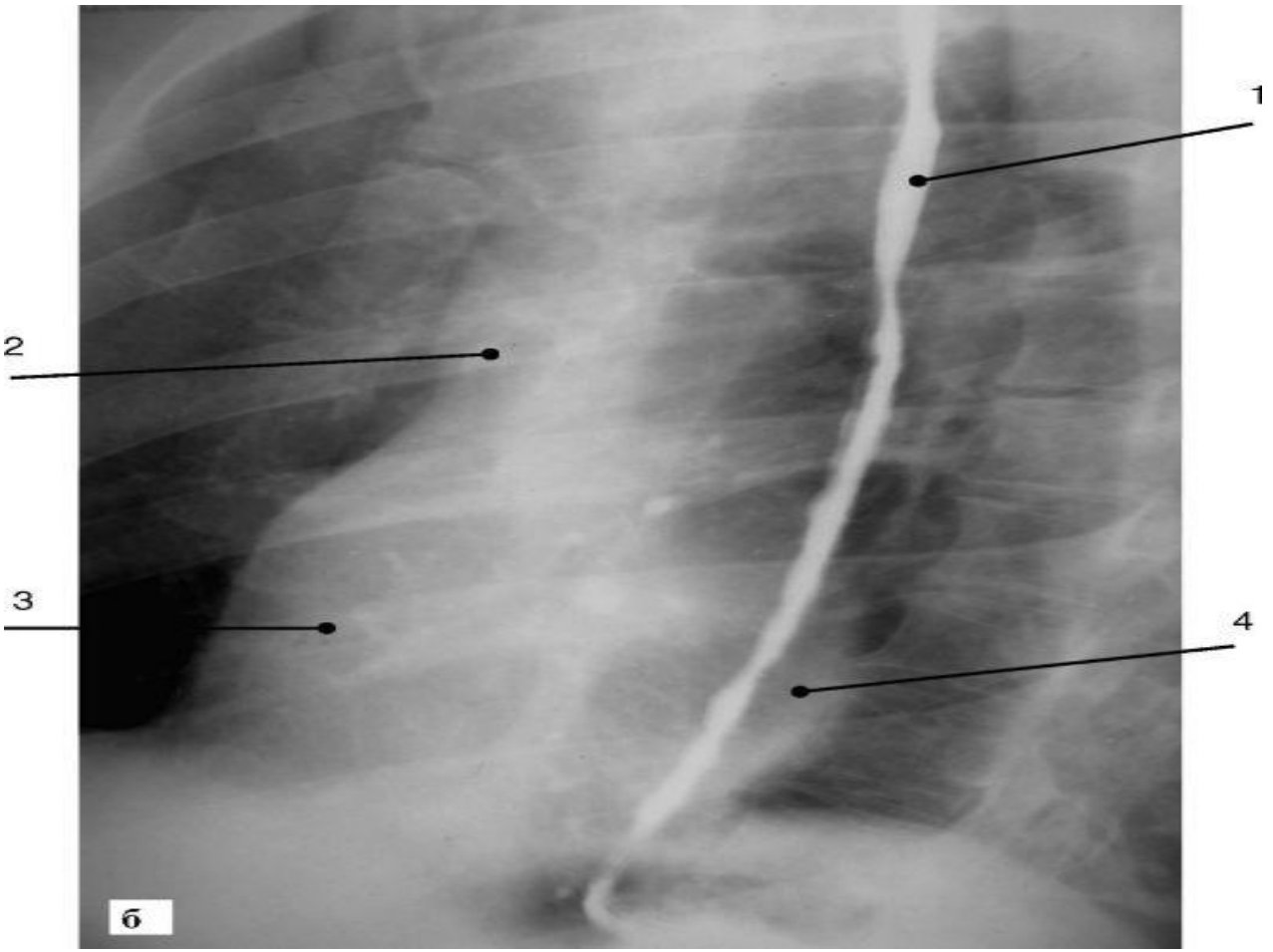
Roentgenogram of the Chest

On the roentgenogram of the chest, most of the middle shadow is the total image of the heart itself and large blood vessels. The heart is represented in the form of an obliquely arranged irregular ellipse, most of which is in the side of the left pulmonary field The median shadow on the radiographs is uniform, so the definition of anatomical elements is carried out along the marginal protrusions ("arches"). In the frontal projection along the right contour of the middle shadow, two shadows are distinguished - the upper one, formed by the upper vena cava, and the lower one, formed by the edge of the right atrium.On the left, four arcs (from top to bottom) are distinguished, formed successively by the aorta, the pulmonary artery, the left atrial ostium, and the left ventricle. On the roentgenogram in the lateral projection, all the parts of the aorta (the ascending part, the arc and the descending part) and the contours of the heart chambers can be viewed. Lateral radiography is performed after contrasting with a sip of barium suspension.

Radiography of the heart in the straight 1 - the shadow of the breast; 2 - ascending aorta; 3 - arch of the aorta; 4 - right atrium; 5 - right ventricle;6 - left atrium; 7 - left ventricle; 8 - the superior hollow vein



Radiography of the heart in the oblique projections: 1 - contrasted esophagus; 2 - ascending aorta; 3 - right ventricle; 4 - left atrium



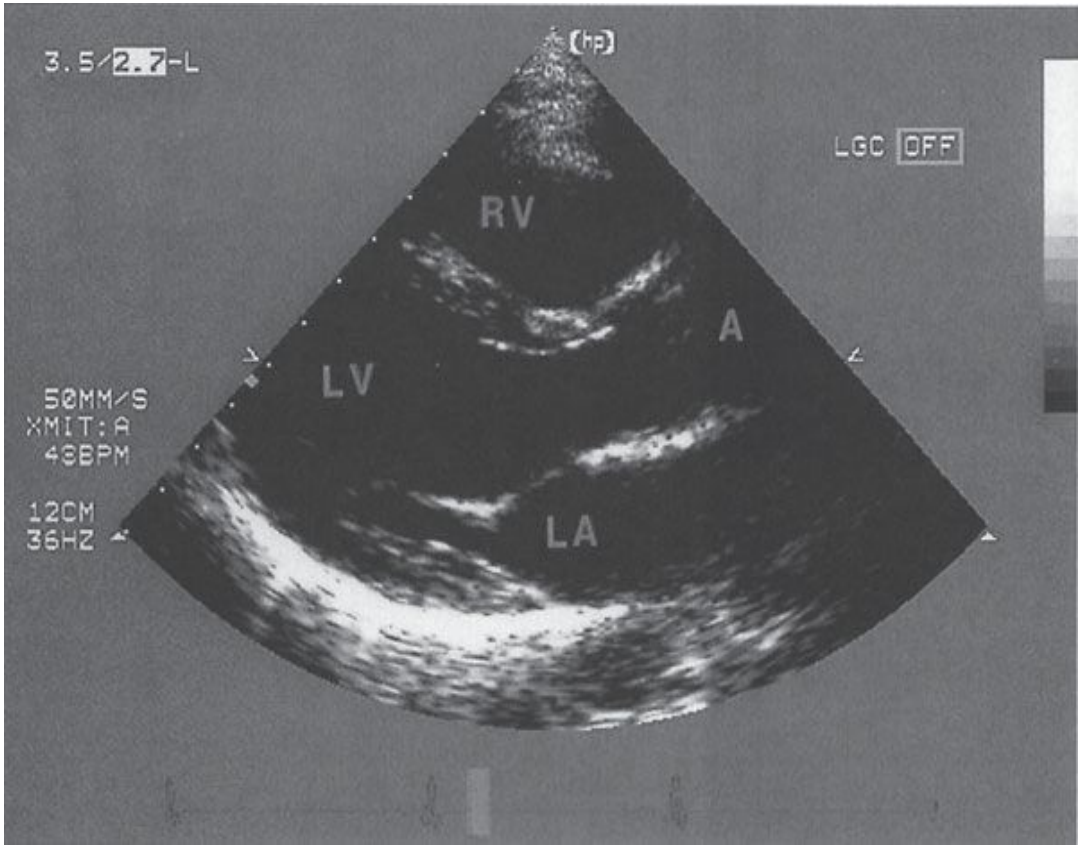
Echocardiography

Echocardiography uses high-frequency ultrasound to evaluate the heart and great vessels. It gives an image of all its structures (with the exception of the coronary arteries). combined with the Doppler technique, yields information regarding cardiac and great vessel blood flow (hemodynamics) as well.Echocardiography is useful in assessing ventricular function, valvular heart disease, myocardial disease, pericardial disease, intracardiac masses, and aortic abnormalities (Figures 3-5 and 3-6).With Doppler technology, cardiac chamber function, valvular function, and intracardiac shunts frequently seen in congenital heart disease can be assessed. In the presence of a bad "ultrasound window", the patient has to resort to transesophageal echocardiography.

Indications for Echocardiography

- ✔ Ventricular function
- ✔ Congenital heart disease
- ✔ Valvular heart disease
- ✔ Cardiomyopathy
- ✔ Pericardial effusion
- ✔ Suspected cardiac masses
- ✔ Aortic disease (proximally)

Normal transthoracic echocardiogram from a healthy subject.

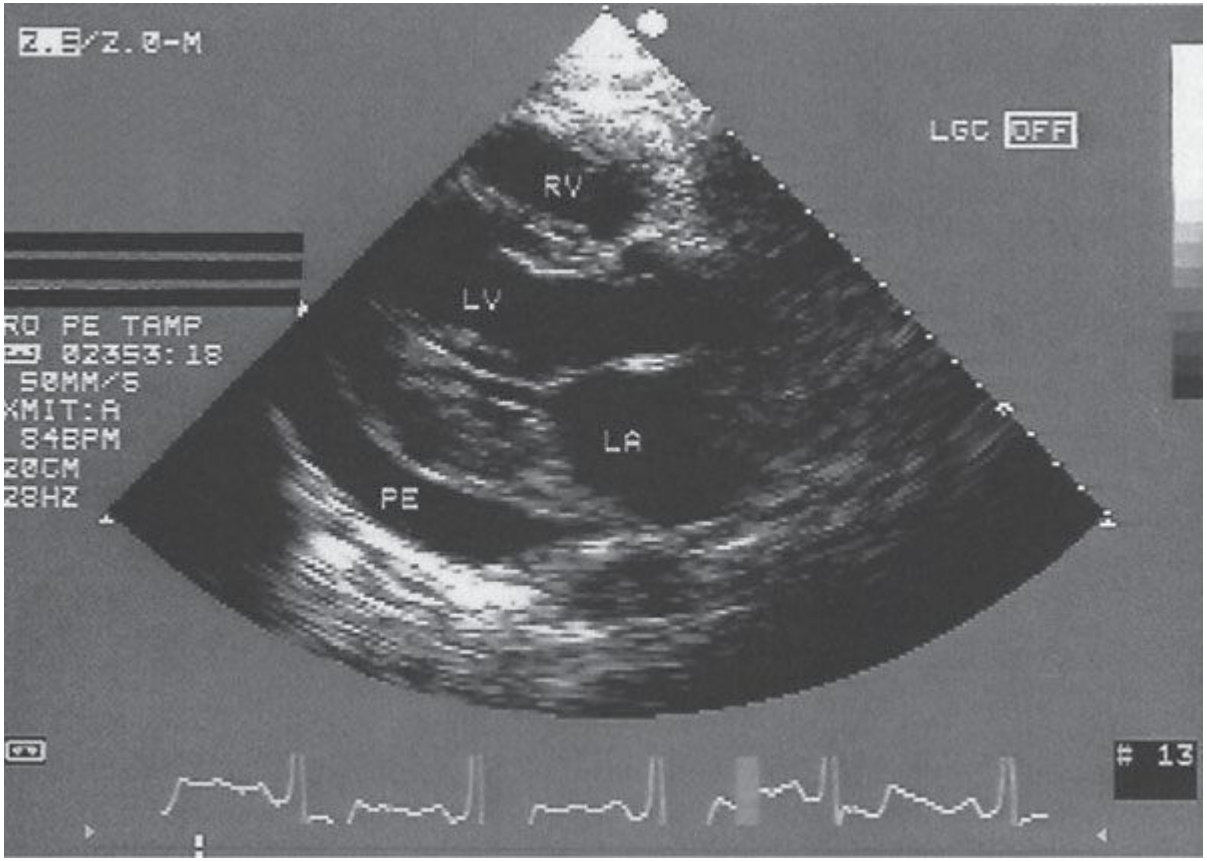


Views are taken from the left

Midparasternal region through an inter costal space. The structure closest to the apex of the screen is the chest wall. The mitral valve, separating the left atrium and left ventricle, is partially open in this image from early systole. A, aorta; LA, left atrium; LV, left ventricle;

RV, right ventricle.

Transthoracic echocardiogram, left parasternal view, from a patient with a moderate-sized posterior pericardial effusion (PE), visualized as a sonolucent space between the epicardium and pericardium. RV, right ventricle; LV, left ventricle; LA, left atrium.



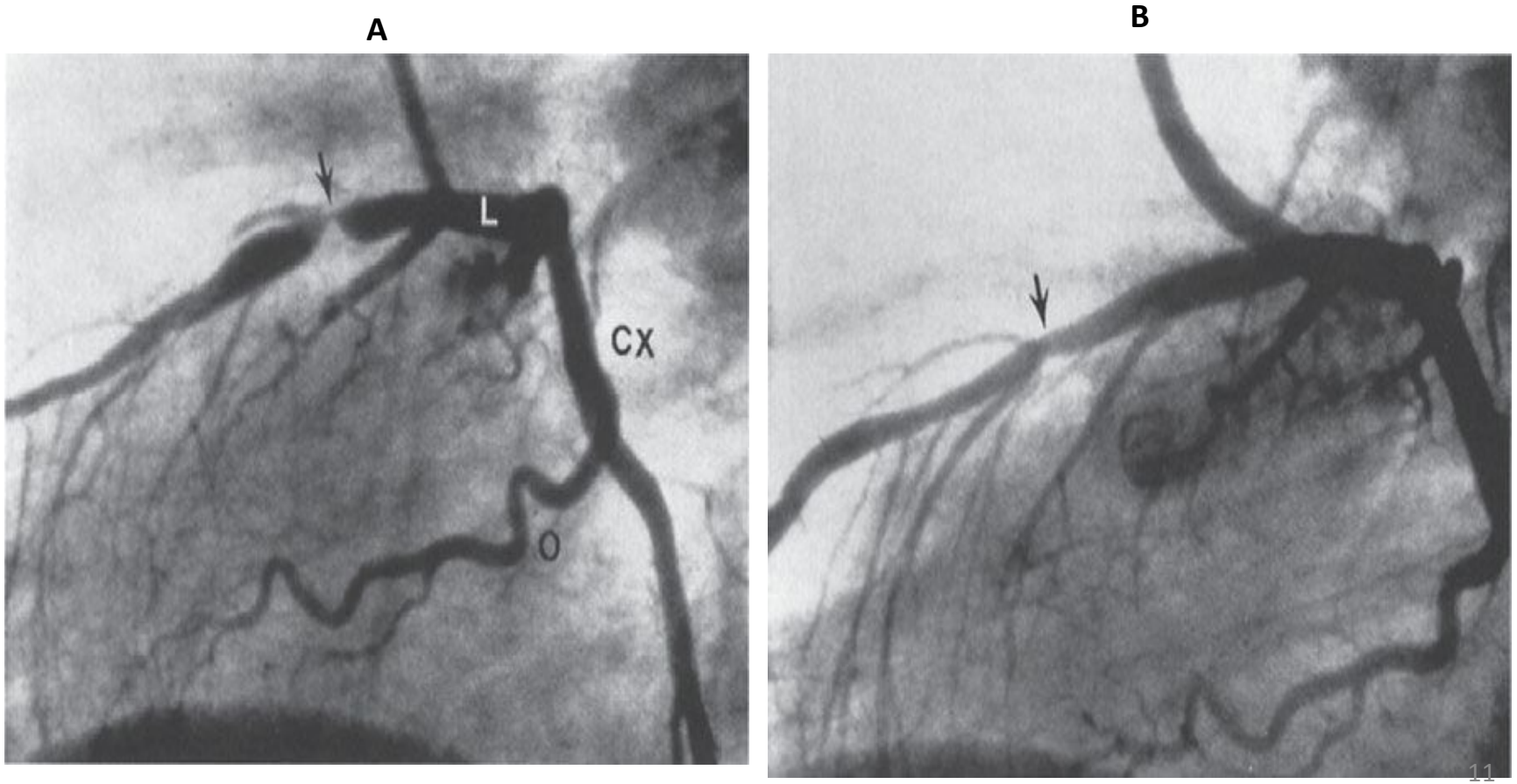
Angiography

Conventional angiography is one of the most commonly performed imaging tests for evaluating the heart and great vessels. After the introduction of a catheter into a peripheral vessel (usually, the femoral or axillary vein or artery), the angiographer, under fluoroscopic visualization, positions the catheter in the region of interest, injects contrast material to confirm the location of the catheter, and then injects larger amounts of contrast material for diagnostic purposes. This injection of contrast material can be videotaped, recorded as standard or digital radiographs, or digitally stored for later review.

There are four major types of angiography:

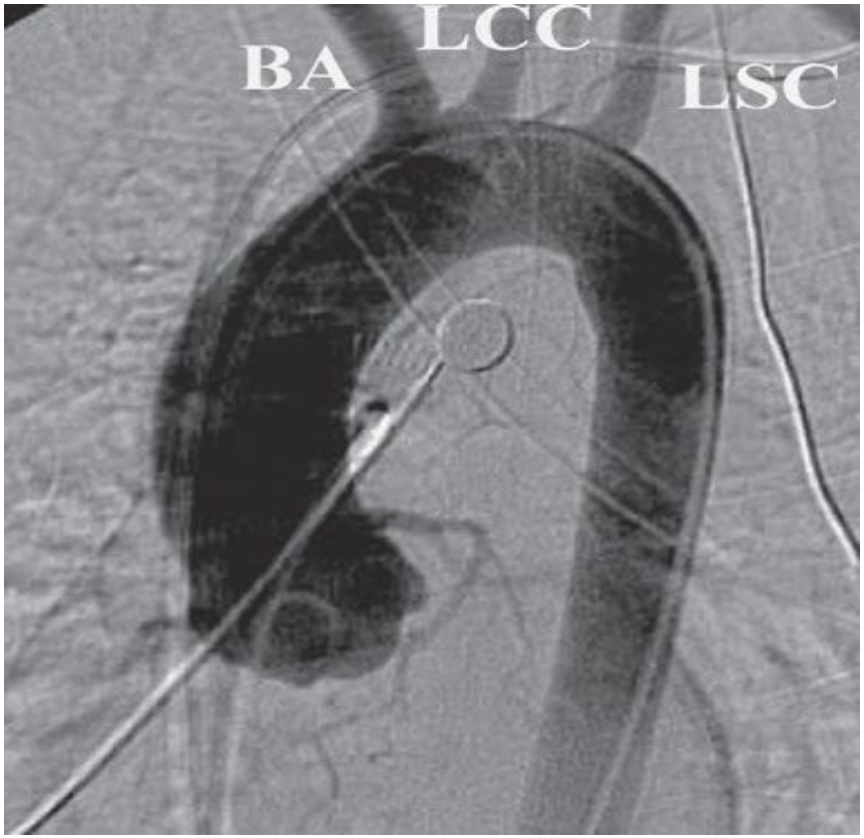
- **Angiocardiography (heart)**
- **Coronary arteriography (coronary**
- **Arteries) aortography (aorta)**
- **And pulmonary angiography (pulmonary arteries and lungs).**

(A) Coronary arteriogram. Images were obtained from the left lateral projection with contrast injection into the left main coronary artery. The left anterior descending (L), left circumflex (CX), and first obtuse marginal (O) branches are visualized. Severe stenosis is seen in the midportion of the left anterior descending artery (arrow) in this patient, who had unstable angina pectoris. (B) Coronary arteriogram, same projection and patient as in (A), obtained 1 day later. The stenosis in the left anterior descending coronary artery (arrow) has been reduced after percutaneous balloon angioplasty.



(A) Normal aortogram of transverse arch in patient suspected of having traumatic aortic injury. Note the normal origins of the brachiocephalic artery (BA), left common carotid artery (LCC), and left subclavian artery (LSC) from the arch of the aorta. (B) Aortogram in a patient with acute traumatic aortic injury. The site of injury is the focal outpouching at the insertion of ductus arteriosus (arrow).

A

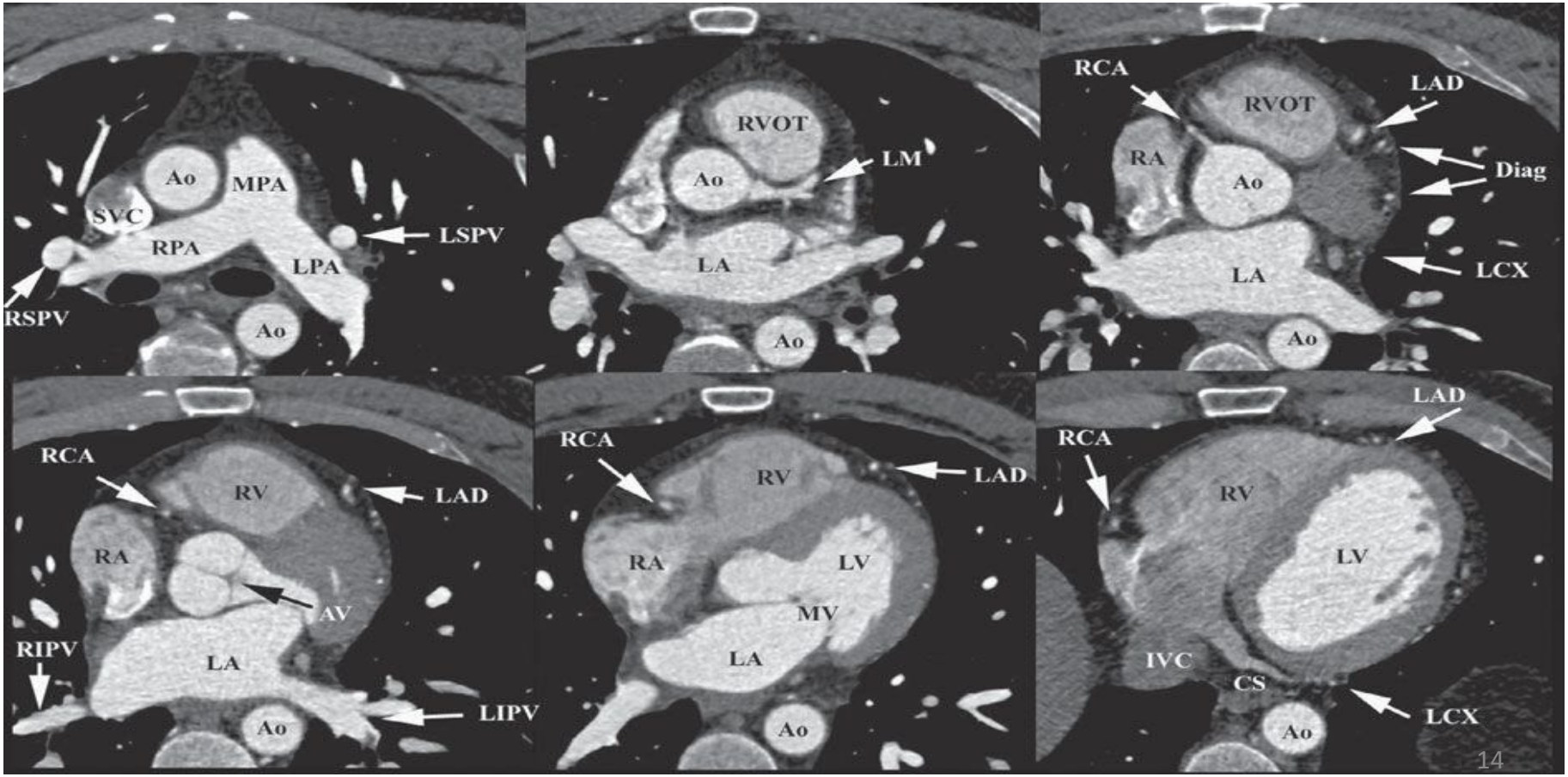


B

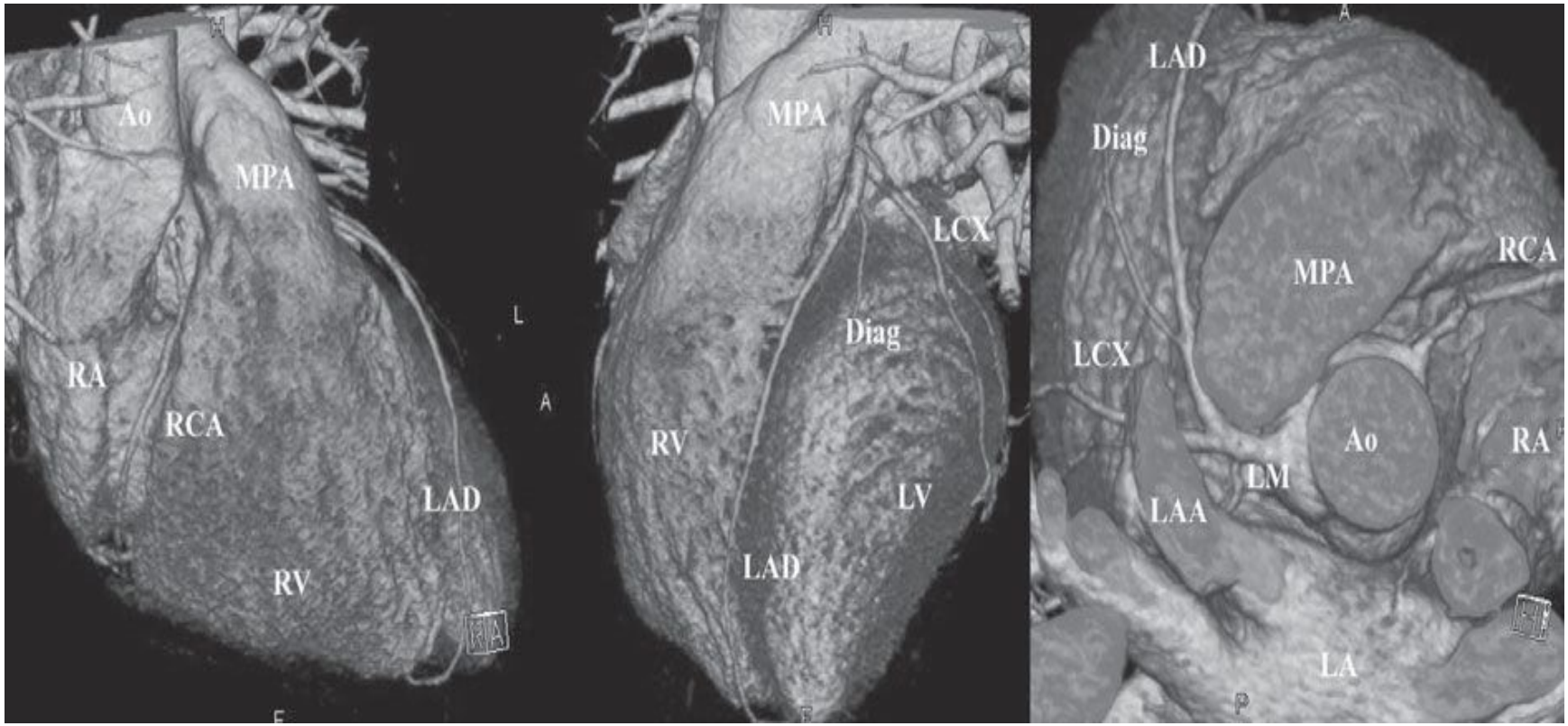
CT in Cardiology

The use of CT in cardiology allows faster and more accurate diagnosis of diseases of the cardiovascular system. In some cases, it is possible to detect coronary artery disease in the preclinical phase.This allows screening of coronary heart disease as the main cause of death in high-risk groups. Heart examination with CT is performed with bolus injection of 80-120 ml of contrast medium into the ulnar vein with cardio synchronization. On computer tomograms all parts of the heart are visible (atria, ventricles, myocardium, valves, chords, papillary muscles, coronary arteries, etc.) (Figure 8-4). Studying the left ventricle in systole and diastole, it is possible to measure ventricular ejection fraction and study their contractile capacity.

Normal anatomy at cardiac CT angiography. Ao, aorta; AV, aortic valve; CS, coronary sinus; Diag, diagonal branch; IVC, inferior vena cava; LA, left atrium; LAA, left atrial appendage; LAD, left anterior descending artery; LCX, left circumflex artery; LM, left main coronary artery; LIPV, left inferior pulmonary vein; LPA, left pulmonary artery; LSPV, left superior pulmonary vein; LV, left ventricle; MV, mitral valve; MPA, main pulmonary artery; RA, right atrium; RCA, right coronary artery; RIPV, right inferior pulmonary vein; RPA, right pulmonary artery; RSPV, right superior pulmonary vein; RV, right ventricle; RVOT, right ventricular outflow tract; SVC, superior vena cava.



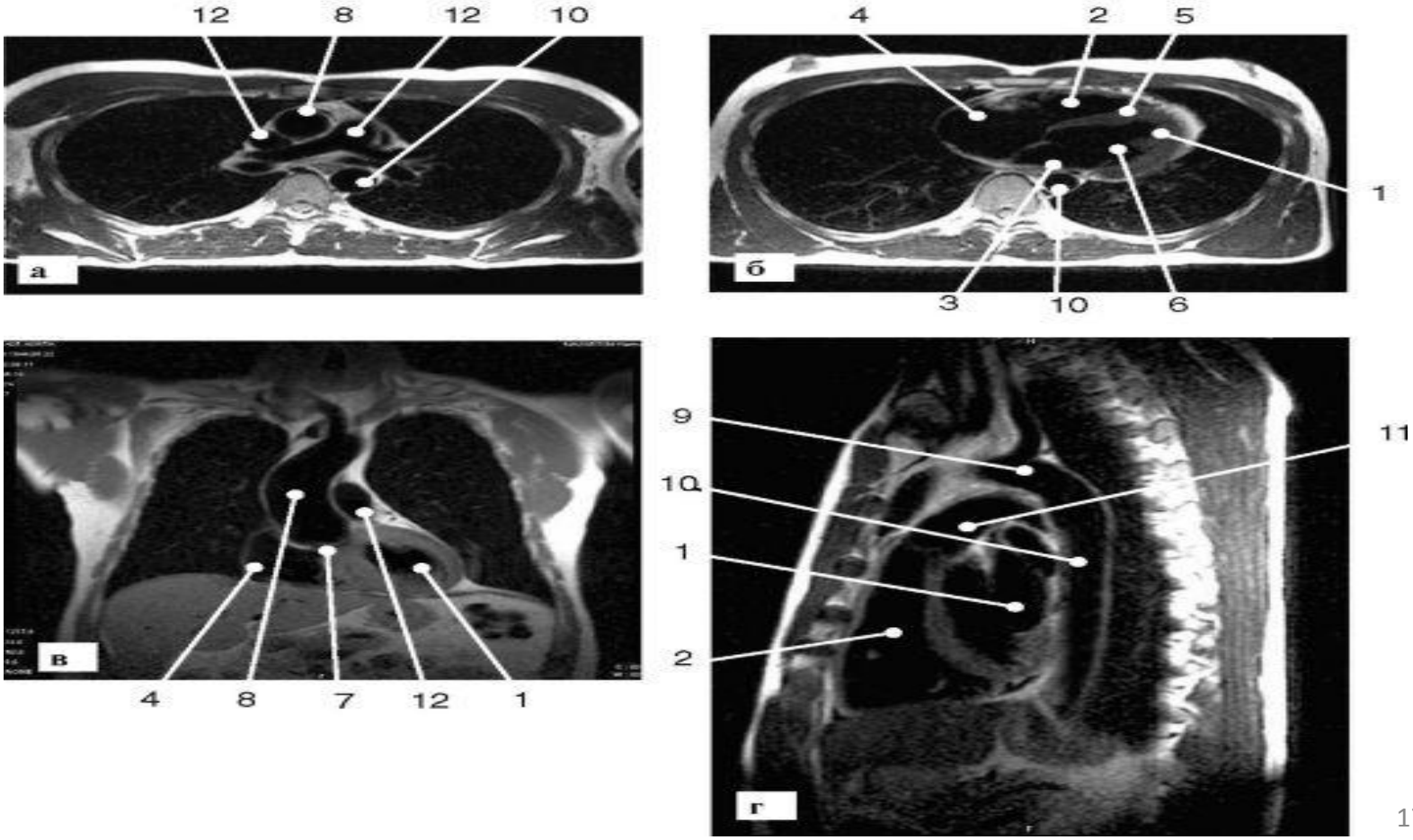
3D volume rendered images in right anterior oblique, left anterior oblique, and cephalad projections (from left to right). Ao, aorta; AV, aortic valve; CS, coronary sinus; Diag, diagonal branch; IVC, inferior vena cava; LA, left atrium; LAA, left atrial appendage; LAD, left anterior descending artery; LCX, left circumflex artery; LM, left main coronary artery; LIPV, left inferior pulmonary vein; LPA, left pulmonary artery; LSPV, left superior pulmonary vein; LV, left ventricle; MV, mitral valve; MPA, main pulmonary artery; RA, right atrium; RCA, right coronary artery; RIPV, right inferior pulmonary vein; RPA, right pulmonary artery; RSPV, right superior pulmonary vein; RV, right ventricle; RVOT, right ventricular outflow tract; SVC, superior vena cava.



MRI IN CARDIOLOGY

MRI is used for the differential diagnosis of cardiac diseases in complicated cases and for the specification of EchoCG data. Using the "cinema-MRI" technique, images of the heart are obtained at various phases of the cardiac cycle. This allows you to assess the speed and nature of the blood flow in the chambers of the heart and the main vessels. There are more complex MR-methods for assessing the perfusion and viability of the myocardium, for which intravenous contrast agents based on gadolinium are administered.

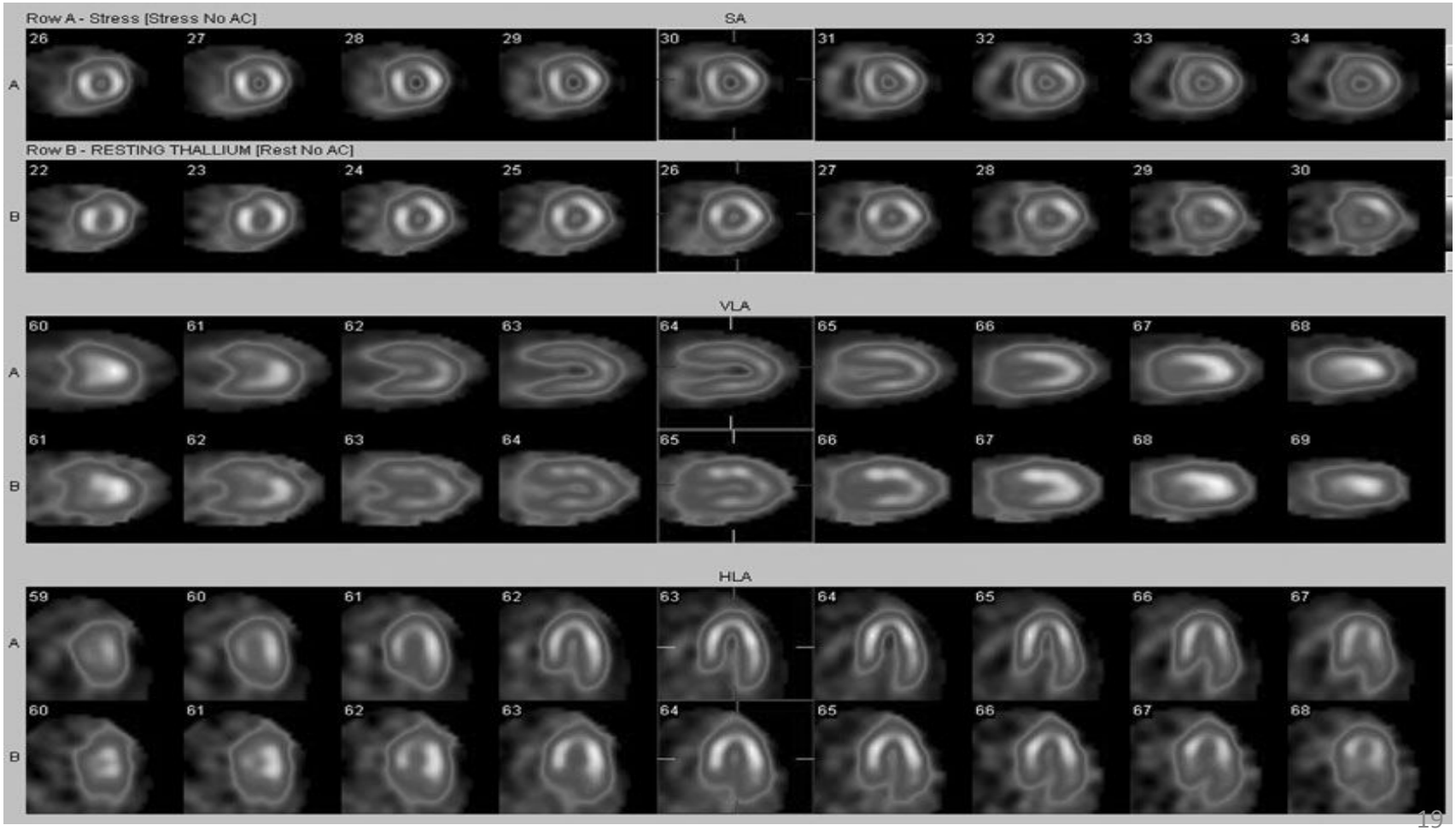
MRI of the heart: a - transverse section at the level of the pulmonary artery trunk; b - transverse section at ventricular level; c - sagittal section through the left ventricle; g - frontal section through the ventricles and the ascending aorta; 1 - left ventricle; 2 - right ventricle; 3 - left atrium; 4 - right atrium; 5 - interventricular septum;6 - mitral valve; 7 - aortic valve; 8 - ascending aorta; 9 - arch of the aorta; 10 - descending aorta; 11 - pulmonary artery; 12 - the superior hollow vein



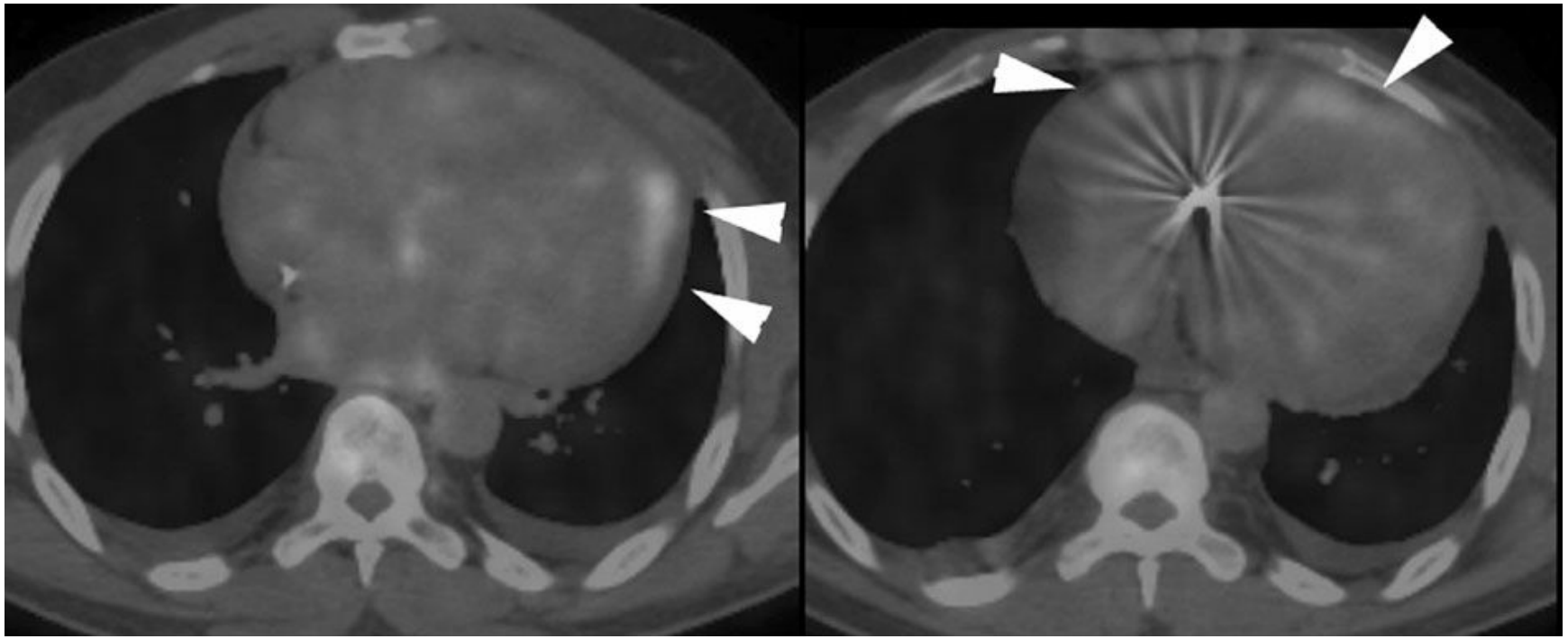
Radionuclide Imaging (Nuclear Medicine)

Radionuclide Imaging (Nuclear Medicine) Cardiac radionuclide imaging, primarily used for the patient with suspected myocardial ischemia or infarction, requires an intravenous injection of radioactively labeled compounds that have an affinity for the myocardium. These compounds localize within the myocardium in diseased or damaged areas, and a radioactivity detector such as a gamma camera can image their distribution. These tests are most commonly used in the evaluation of patients with angina and atypical chest pain. Gallium scans are occasionally used to assess for intrinsic myocardial disease such as myocardial sarcoidosis. Positron emission tomography (PET) with 18FFDG (18F-fluorodeoxyglucose) is a problem-solving tool that has shown promise in assessing myocardial viability in patients with known coronary artery disease and to assess for metabolically active infiltrative disease .In addition, rubidium-82 and nitrogen-13 ammonia have been used as PET agents to evaluate myocardial perfusion.

Normal myocardial stress/rest study. Stress imaging performed with technetium-99m tetrofosmin following treadmill exercise achieving target heart rate. Resting images performed using thallium-201. Homogeneous perfusion of the left ventricular cavity is seen with both stress images (top of image pairs) and rest images.

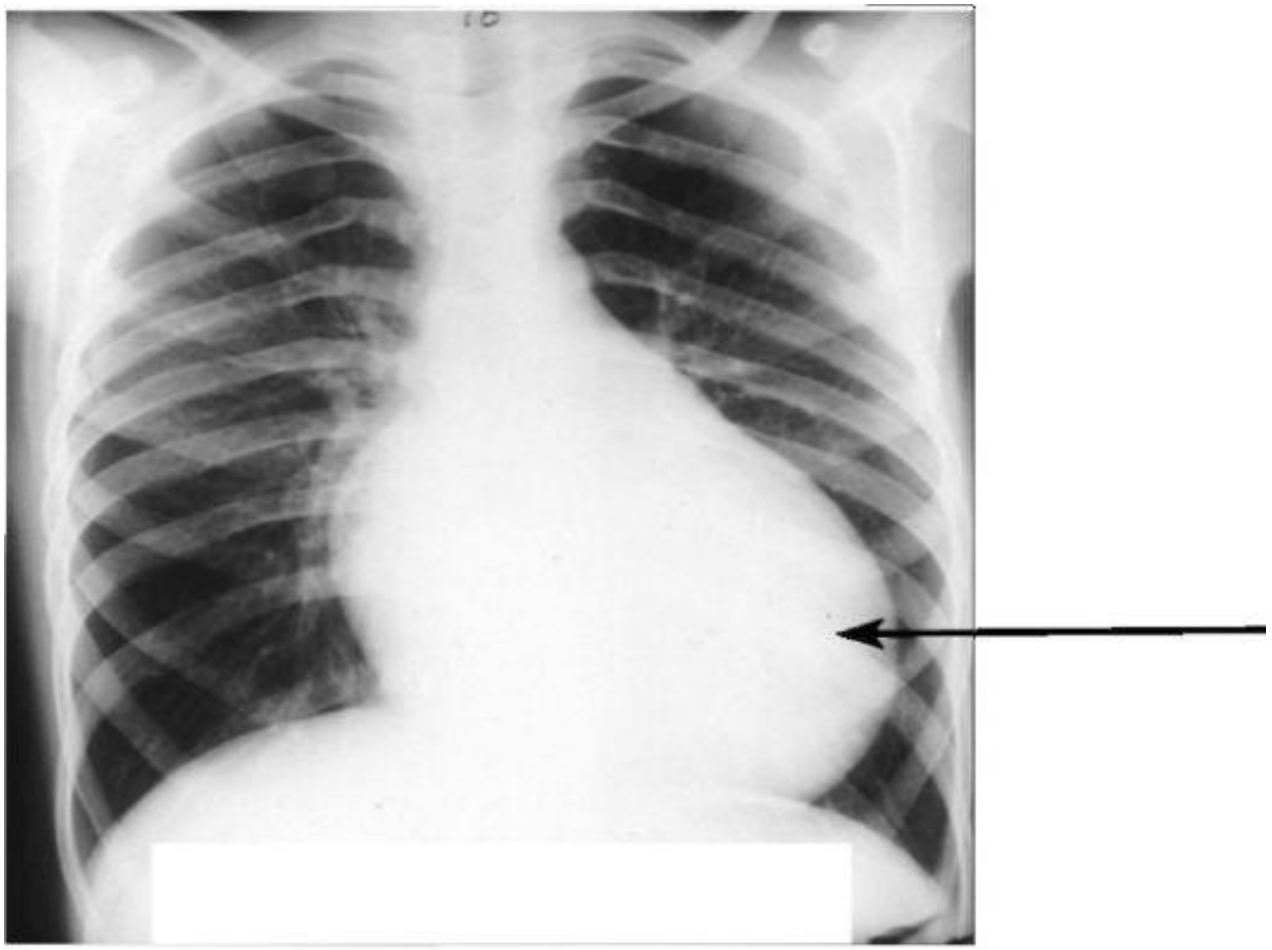


18F-FDG-PET cardiac study performed after 24-hour fast shows patchy myocardial activity due to cardiac sarcoidosis (arrowheads). Normal myocardium is suppressed because of glucose deprivation and change in metabolism to free fatty acids.

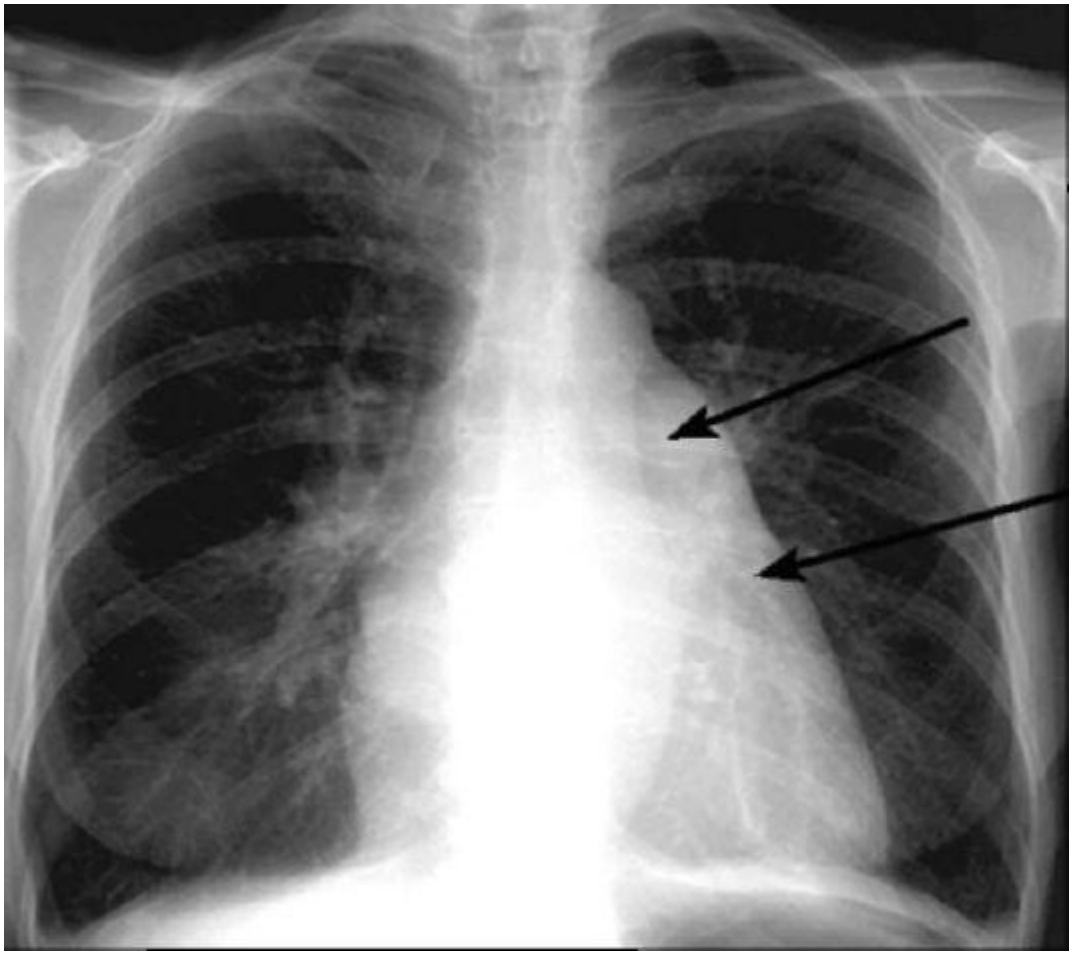


PATHOLOGICAL RADIOLOGY
OF
CARDIOVASCULAR SYSYTEM

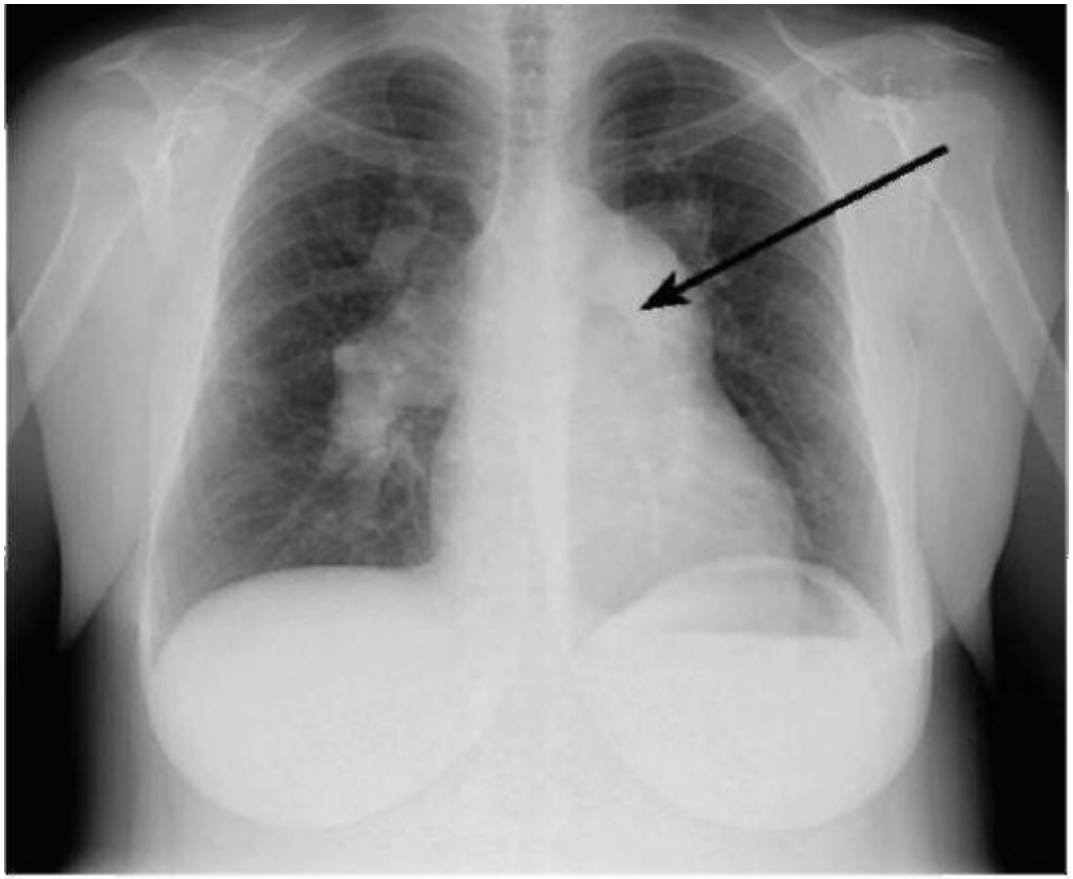
Radiograph of the heart with an increase in the left ventricle. Aortic configuration of the heart.



Radiography of the heart with an increase in the left atrium. Mitral configuration of the heart. Direct projection.

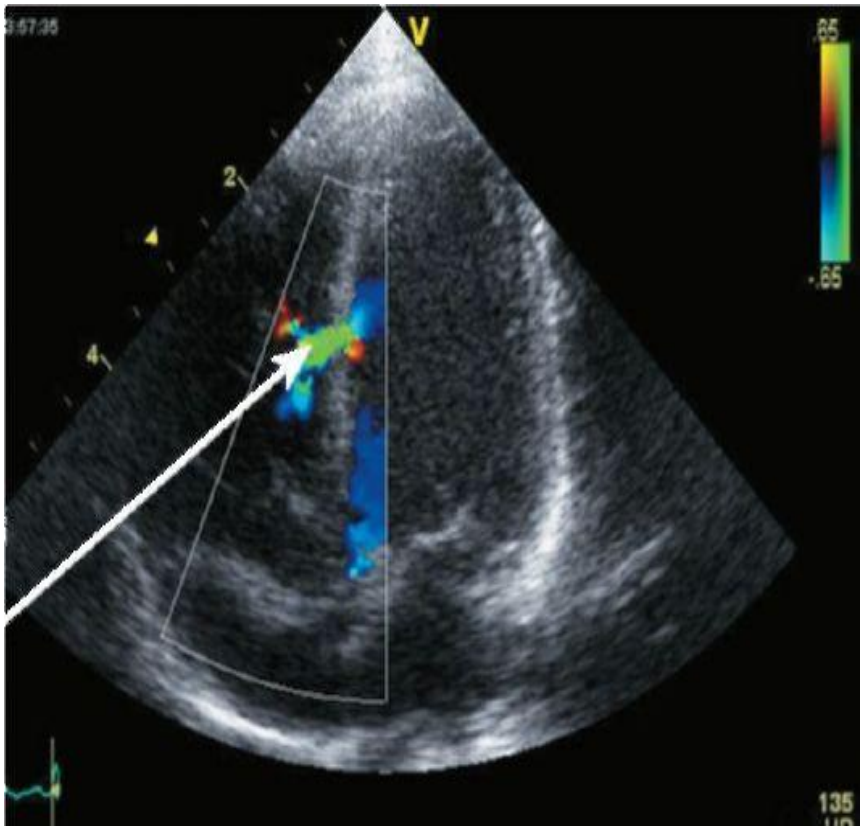


An increase in the right heart with pulmonary hypertension. Direct projection. Signs of an increase in the pulmonary artery (arrow)

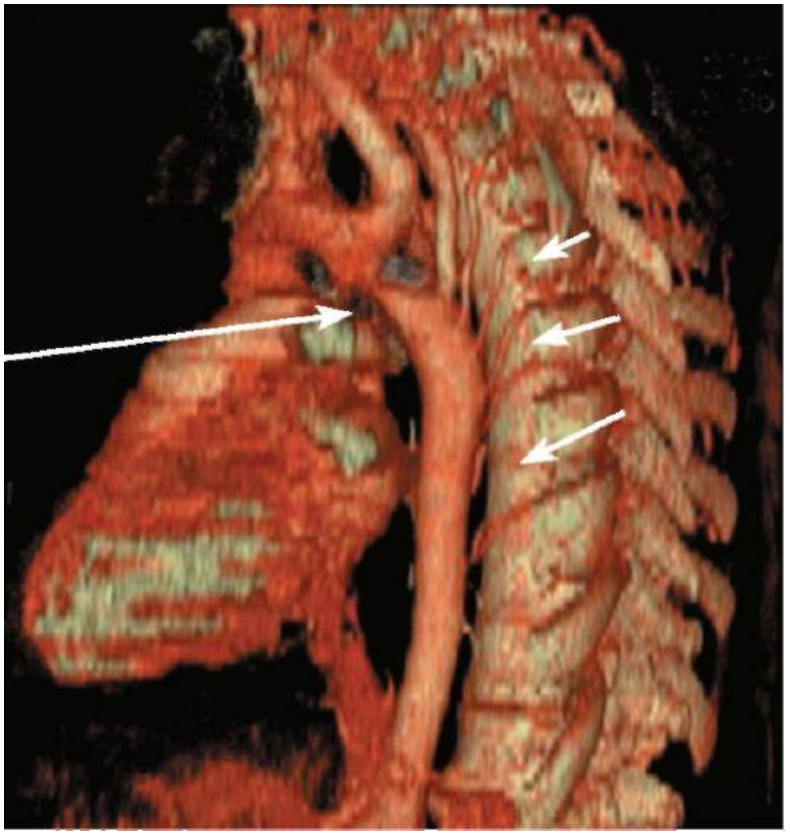


Congenital heart disease without cyanosis

Transthoracic echocardiography.Defect of interventricular septum. There is a hole in the interventricular septum (arrow).

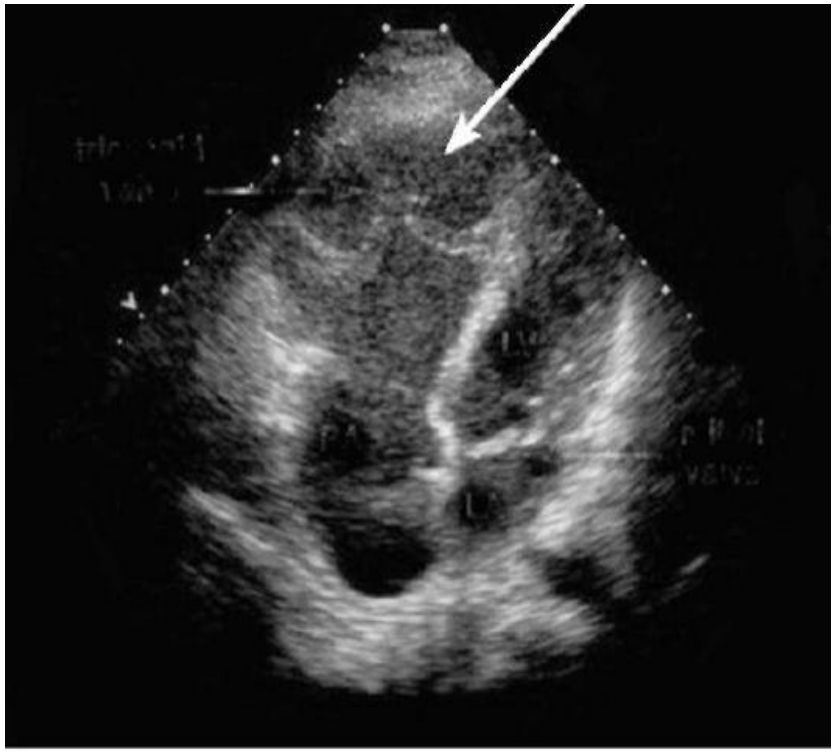


Clearly visible area of coarctation (arrow), multiple enlarged rib arteries (small arrows)



Congenital heart disease with cyanosis and normal pulmonary circulation

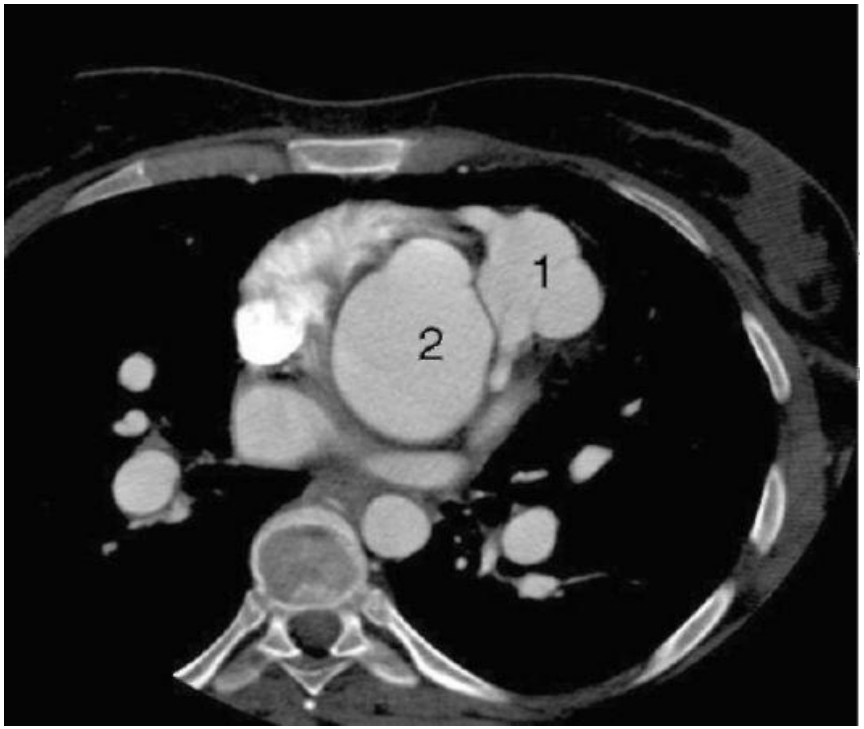
An echocardiogram with an Ebstein anomaly. The cavity of the right ventricle is enlarged, in its depth there is a tricuspid valve (arrows)



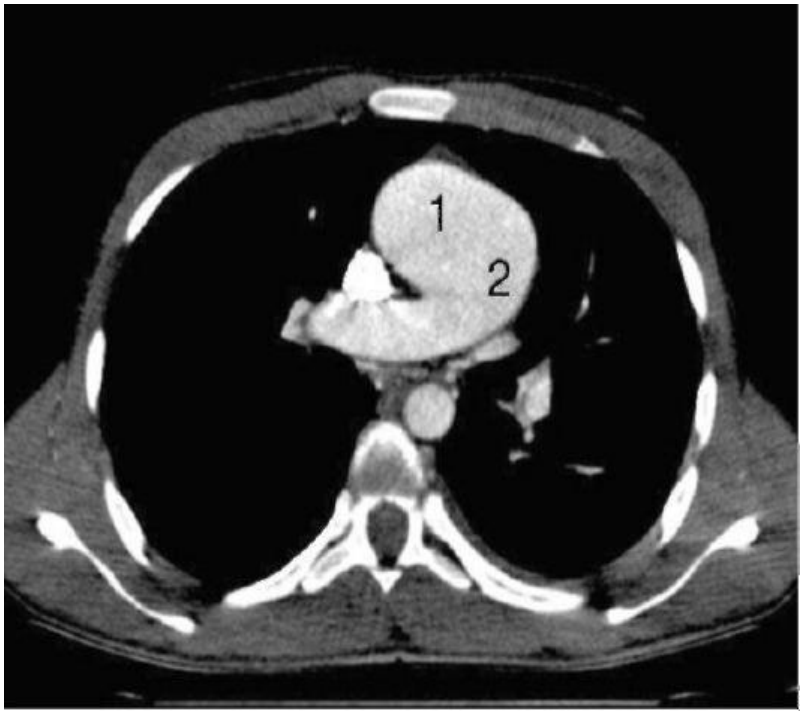
TetradaFallot: chest radiograph

Congenital heart diseases with cyanosis and increased pulmonary circulation

angiography with transposition of the main arteries. The reverse location of the ascending aorta (1) and the pulmonary artery trunk (2)



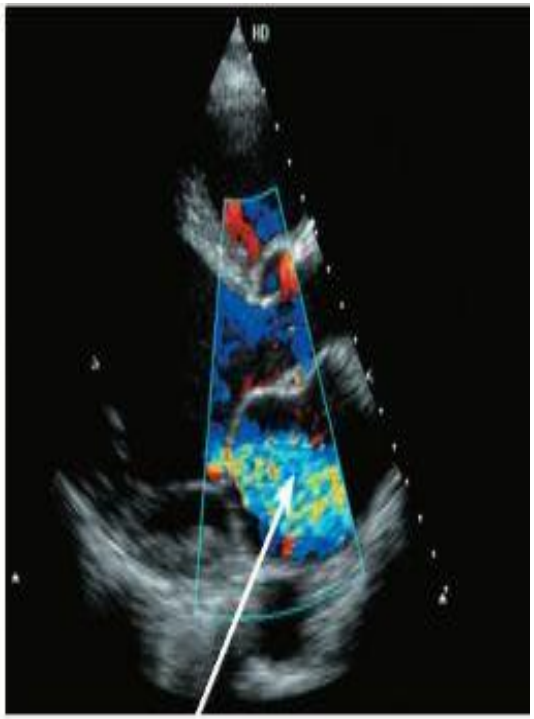
angiography. Cross section. The common arterial trunk. There is no separation of the ascending aorta (1) and the pulmonary trunk (2)



Echocardiography with defects of the mitral valve

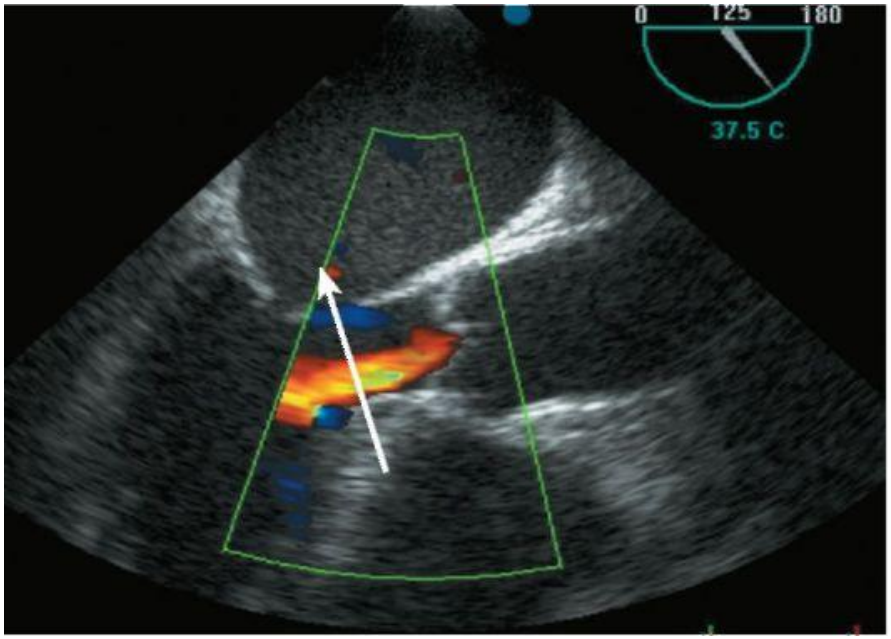
a - stenosis of the left atrioventricular orifice. Diastole. 1 - LV. 2 - Pancreas. The arrow indicates the thickened valves of the mitral valve with limited opening;

b - color Doppler study with mitral insufficiency.Systole. The flow of mitral regurgitation spreads to the left atrium (indicated by an arrow)



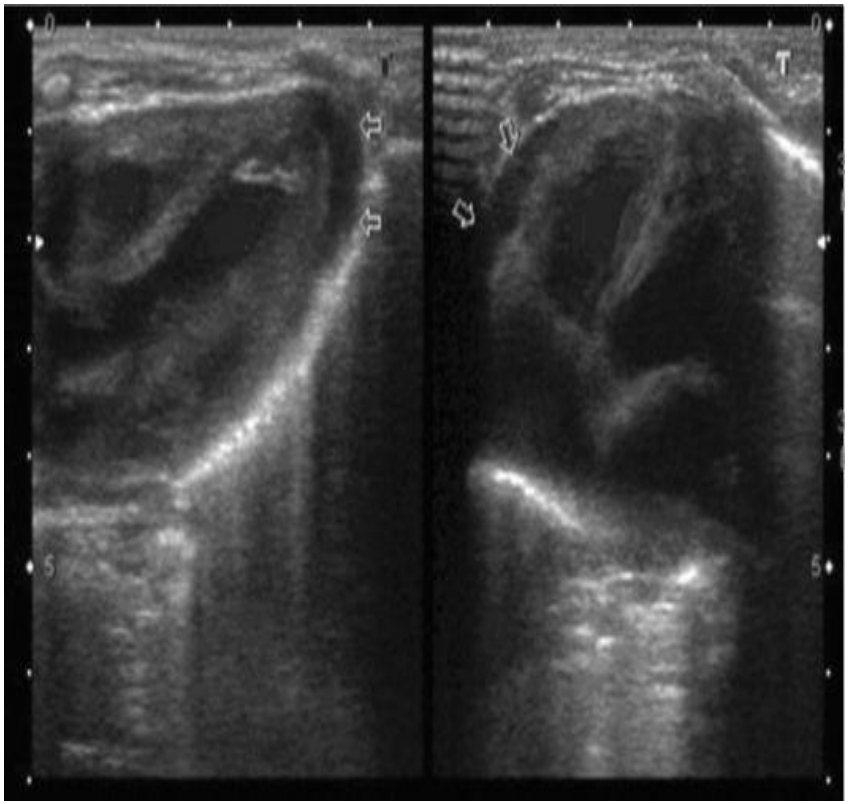
Echodopplerography with aortic valve insufficiency

The arrow indicates the retrograde flow of blood through the closed valves of the aortic valve in the diastole (arrow)

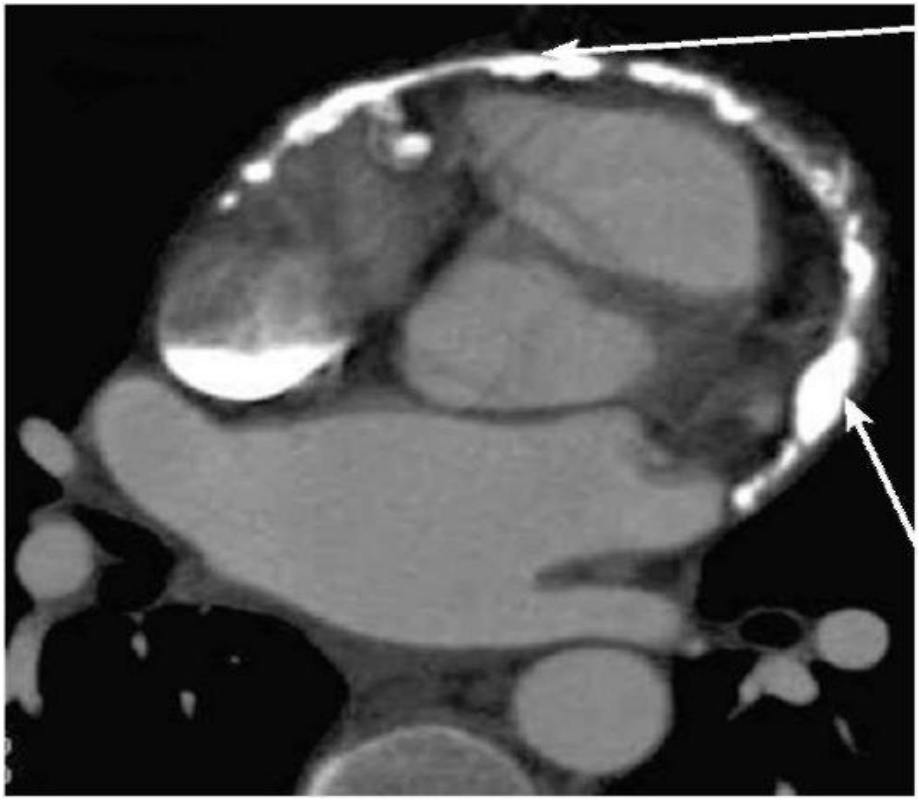


DISEASES OF PERICARDIUM

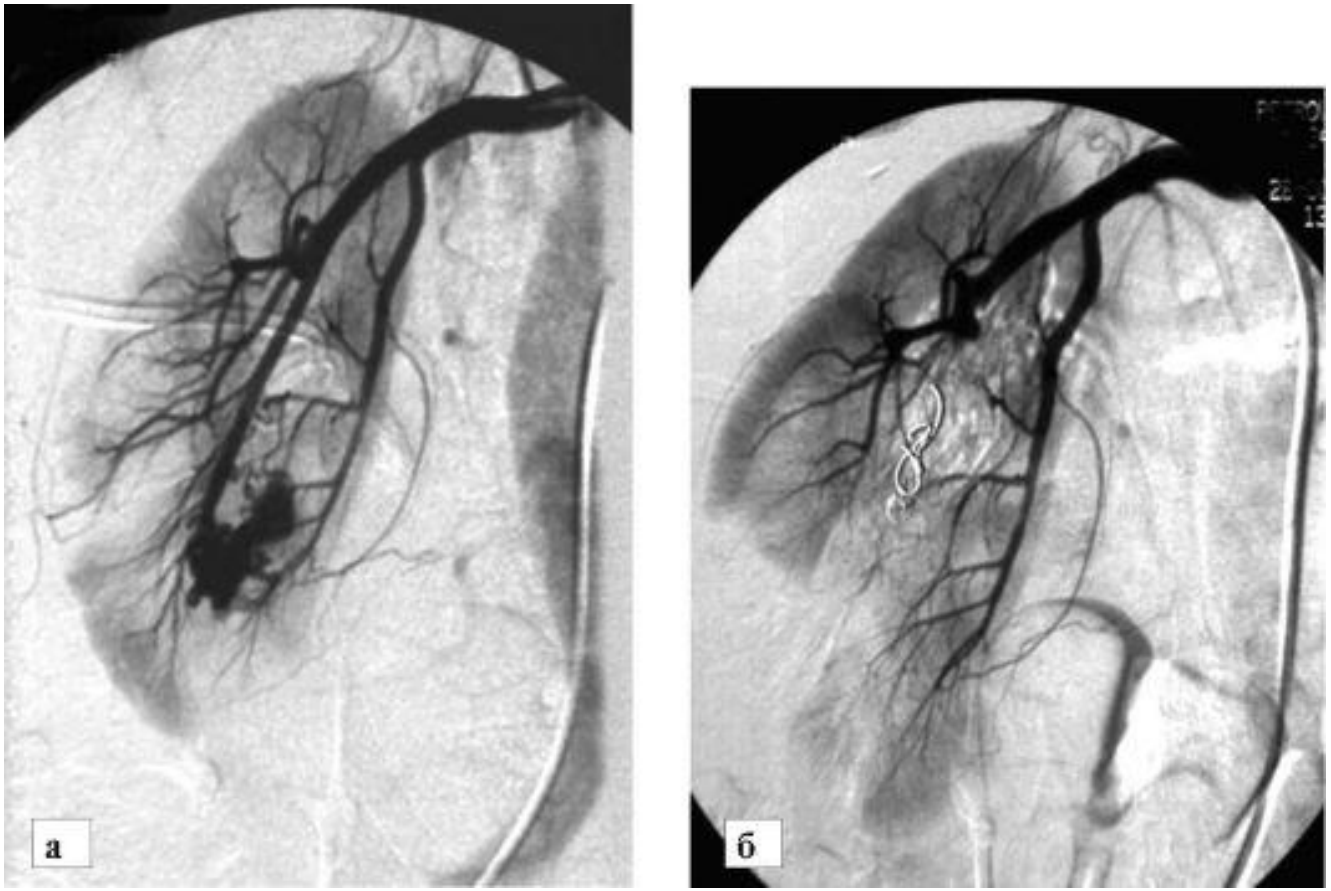
Echocardiography with exudative pericarditis.Before the right and behind the left ventricle, a free echo-negative space (arrows)



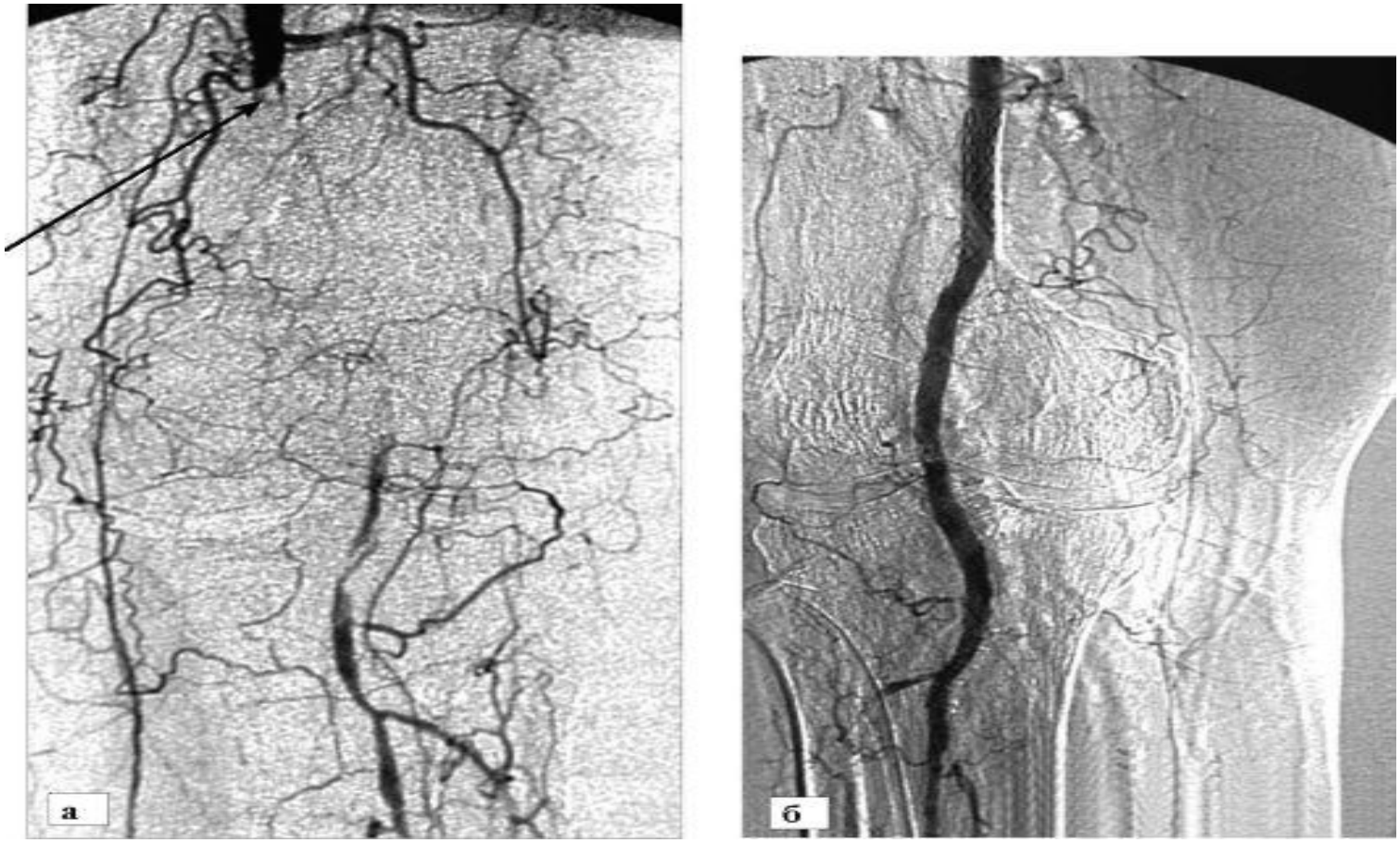
CT with constrictive pericarditis.In the transverse section, thickened, unevenly calcined pericardial sheets (arrows)



Diagnosis and treatment of arteriovenous fistula of the right kidney: a - on the angiogram, a network of dilated vessels formed as a result of congenital arteriovenous fistula is visualized; b - after embolization with micro-spirals (indicated by an arrow), contrasting pathological vessels disappeared.



Angiography of the femoral and popliteal arteries: a - a "breakage" of the lumen of the femoral artery in the lower third (arrow) is visible. There is a pronounced network of collaterals; b - angiography performed after opening of occlusion and stenting (stent is indicated by an arrow) of the affected area. Complete restoration of blood flow along the vessel.



X-ray of the chest with aneurysm of the descending aorta.The descending aorta is enlarged and deflected to the left (arrow), which leads to a pronounced change in the configuration of the shadow of the heart and mediastinum in the image.