Cardiovascular Imaging Modalities

Anatomic elements

- Heart and great vessels
- Pulmonary vessels
- Peripheral vessels

Methods of examination

- Radiology
- Echocardiography (Ultrasonography)
- Magnetic resonance imaging (MRI)
- Nuclear medicine

Radiology

Conventional radiography

- Contrast radiography :
 - Angiography

aortography coronography

angiopulmonography

peripheral angiography

Ventriculography (cardiac catheterization)

Computed tomography

Radiology

Radiography

Conventional radiograph (Chest X-ray)

- **PA**
- LL
- OBLIC
 - RAOP
 - LAOP
- Fluoroscopy



Chest radiograph value

- Cardiac position
- Cardiac dimensions assessment
- Cardiac configuration
- Pulmonary circulation (pulmonary vasculature)
- Mediastinal exploration

Radiology

Contrast examination

- Ventriculography
- Angiography
 - Aortography
 - Angiocoronarography
 - Arteriography
 - Flebography





Left cardiac catheterization

DIASTOLE

SYSTOLE



Right cardiac catheterization



Ventriculography



Angiocoronarography





Angiocoronarography



Angiocoronarography



Indications for cardiac catheterization and coronary angiography

- **Coronary artery disease** (ventricular tachicardia, angina, acute myocardial infarction, persistent or recurrent ischemia, severe pulmonary edema etc)
- Valvular heart disease (infective endocarditis with coronary embolization, mitral regurgitation, aortic regurgitation, cardiac enlargement, reduced ejection fraction, prevalve surgery in patients with coronary artery disease risk factors)
- **Congenital heart disease** (prior to surgical correction, suspition for congenital coronary anomalies)
- **Pericardial disease** (cardiac tamponade, constrictive pericarditis)
- **Cardiac transplantation** (preoperative and postsurgical evaluation)
- **Other conditions** (hypertrophic cardiomyopathy, diseases of the aorta with coronary artery involvement etc)

Peripheral angiography



Computed Tomography

Cardiac CT indications:

Pathological conditions of

- Aorta and coronary vessels
- Complex congenital heart diseases
- Acquired valvular diseases
- Pericardium
- Mediastinum



- 1 Right Ventricle
- 2 Left Ventricle
- 3 Interventricular septum





CT without contrast media Calcification of coronary artery



CT without contrast media Pericardial calcification



Computed Tomography

CT angiocoronarography



СТ

Angiocoronarography



Angiocoronarography: 3D reconstruction





Β

CT-3D



CT-3D





Echocardiography

ECOCG: transthoracic; transesophageal

mode: M 2D (B-mode) 3D contrast ECOCG **Doppler ECOCG** pulsative Doppler continual Doppler color Doppler tisular Doppler





Echocardiography

- Cardiac anatomy study (cardiac chambers size, wall thickness, valvular morphology and motion, masses)
- Intracardiac and great vessels hemodynamic assessment (valve stenosis, regurgitation, intracardiac pressures, volumetric flow, diastolic filling, intracardiac shunts)
- Myocardial contractility evaluation (global contractility, regional wall motion abnormalities)
- Pericardium examination (pericardium effusion, tamponade)





Transthoracic echo windows



Echocardiography B-mode

- **B-mode or 2D mode**: In B-mode (brightness modulation) ultrasound, a linear array of transducers simultaneously scan a plane through the body that can be viewed as a 2-D image on screen.
- More commonly known as 2D mode now.



Echocardiography B-mode


















Modes 3D / 4D

The 3D and 4D mode represents the three-dimensional virtual reconstruction (4D = 3D + time) of the investigated structures, based on the results of the real two-dimensional scan.



Modes 3D / 4D



M-mode

- used to image moving structures;
- signals reflected by the moving structures are converted into waves that are displayed continuously across a vertical axis;
- is used primarily for assessment of fetal heartbeat and in cardiac imaging.





<u>M-E</u>COCG

Doppler ECOCG



Pulse Doppler

- A pulse is sent out, and the frequency shift in the reflected pulse is measured after a certain time.
- This will correspond to a certain depth (range gating), i.e. <u>velocity is measured at a</u> <u>specific depth, which can be adjusted</u>.
- Used for peripheral vessels examination.



Pulse Doppler - femoral artery

Continuous Doppler

- The ultrasound beam is transmitted continuously, and the received echoes are sampled continuously.
- There is no information about the time interval from the signal to the reflection, and, hence, no information about the depth of the received signal.
- It is used for measuring high velocities (valvular or vascular stenosis).



Color Doppler





Color-Doppler

- In the sampling area (color box) the flow to the transducer is encoded in red, and from the transducer in blue.
- Different shapes of colors are displayed at the site of strictures, turbulent flow, etc.



Color-Doppler imaging of the mitral valve, for assessment of regurgitation.

Doppler tissular

• Tissular Doppler allows real-time assessment of moving tissues, which allows for assessment of regional movement of myocardial walls.



2D ECOCG. Single ventricle



Ultrasonography Interventricular septal defect





Transesofagial ECOCG Interatrial septal defect



Cardiovascular MRI

• Cardiovascular magnetic resonance imaging (CMR), known as cardiac MRI, is a medical imaging technology for the noninvasive assessment of the function and structure of the cardicac system.

Cardiovascular MRI



Indications for cardiac MRI include:

- Coronary artery disease
- Cardiomyopathies
- Cardiac and pericardiac masses and thrombi
- Pericardial disease
- Valvular heart disease
- Congenital heart disease (CHD)
- Diseases of the aorta and great vessels

Coronary Angiography



 Stenosis of proximal LAD (*arrows*) and proximal LCx (*arrowheads*) on coronary MR

Coronary Angiography



Cardiovascular MRI



Aortic View





Assessment of Cardiac Function and Volumetrics

Measurement	Normal range
Left Ventricular End Diastolic Diameter (LVEDD)	<5.6 cm
Right Ventricular End Diastolic Diameter (RVEDD)	<lvedd< td=""></lvedd<>
End Diastolic Thickness (EDT)	<1.1 cm
Right Atrial End Systolic Diameter (RAESD)	<4.0 cm
Left Atrial End Systolic Diameter (LAESD)	<4.0 cm





Cine cardiovascular MRI





Dilated Cardiomyopathy



• Dilated cardiomyopathy demonstrating global dysfunction on cine cardiovascular MRI.

Hypertrophic cardiomyopathy



• severe increase in left ventricular wall thickness

Cardiac Tumors



Cine cardiovascular MRI

Pericardial Effusion



• Fluid collection in the pericardial space (arrowhead)

Constrictive Pericarditis and Pericardial Thickening



 Pericardium is thicker than the normal 3 mm (arrowhead). This finding is consistent with constrictive pericarditis.



 Effusive constrictive pericarditis. Septated pericardial effusion (arrow) and the thickened pericardium (arrowhead).

Aortic Aneurysm



• MR-Angiography

Aortic Dissection





 ascending aortic dissection. An intimal flap in the axial image. The MIP image shows the resulting aneurysmal dilation.

Nuclear Medicine

- Nuclear angiocardiography
- Myocardial perfusion scintigraphy, SPECT, PET

Indications

- Detection of myocardial viability (resting ischemia, hibernating myocardium)
- Acute imaging in myocardial infarction and unstable angina



Nuclear medicine: SPECT


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Myocardial scintigraphy-normal



24-Oct-21

Myocardial scintigraphy- myocardial infarction

