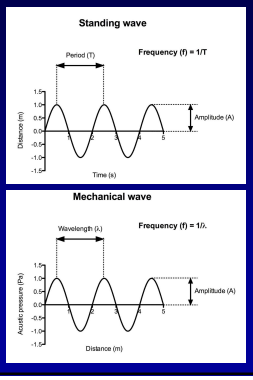
ECHOCARDIOGRAPHIC EXAMINATIONS I.

STANDARD VIEWS, NORMAL VALUES

UNIVERSITY OF DEBRECEN
FACULTY OF MEDICINE
DIVISION OF CLINICAL PHYSIOLOGY

TÁMOP-4.1.1.C-13/1/KONV-2014-0001

Physical basis of echocardiography

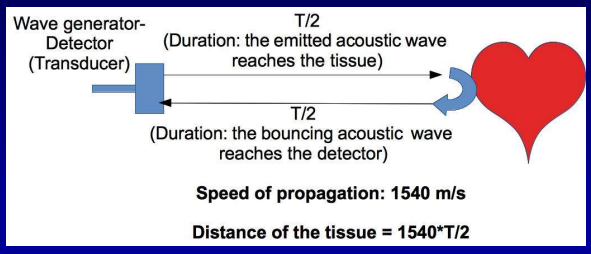


Resolution: positive relationship with the frequency

Penetration: negative relationship with the frequency

Optimal frequency: 2-20 MHz

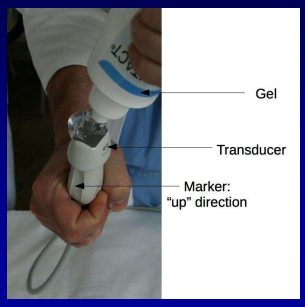
Distance in echocardiography



Speed of propagation: 1540 m/s

Distance of the tissue = 1540*T/2

The transducer and the beginning of examination



Transducer: emitter and detector

Transducer direction

Echocardiographic gel

Transthoracic echocardiographic examination

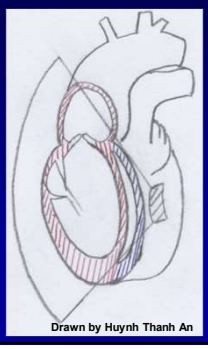
Transducer position: parasternal long axis view

Transducer position: 3rd intercostal space left to the sternum

Transducer direction: mark points towards the right shoulder

View: long axis view

Transducer position: parasternal long axis view



Drawn by Huynh Thanh An

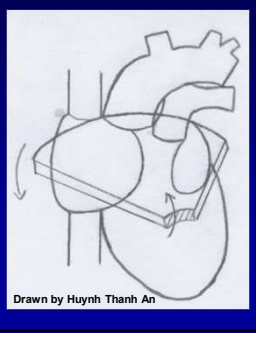
Transducer position: parasternal short axis view

Transducer position: 3rd intercostal space left to the sternum

Transducer direction: mark points towards the left shoulder

View: short axis view (tilting of the transducer for different sections)

Transducer position: parasternal short axis view



Drawn by Huynh Thanh An

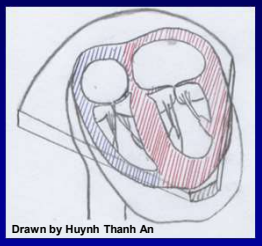
Transducer position: apical view

Transducer position: 5th intercostal space, above the area of apex beat

Transducer direction: rotate for 5 chamber, 4 chamber, 2 chamber views

View: apical view (rotating of the transducer for different sections)

Transducer position: apical view



Drawn by Huynh Thanh An

Modes in echocardiography, normal values

‚B' (Brightness) mode: 2D pictures

‚M' (Motion) mode: morphometric measurements

Doppler mode: blood flow direction and velocity

Mode of determination	*Parameter*	*Normal values*
M-mode	Ejection fraction (%)	>50
M-mode	Thickness of the ventricular wall (diastolic, mm)	<12
M-mode	Diameter of the left ventricle (diastolic, mm)	<55
M-mode	Diameter of the left ventricle (systolic, mm)	<40
M-mode	Diameter of the left atrium (diastolic, mm)	<40
B and Doppler modes	Surface of the orifice of the aortic valve (systolic, cm^2)	3-4
Doppler-mode	Aortic pressure gradient (mmHg)	<5
Doppler-mode	E/A	1,0-1,9

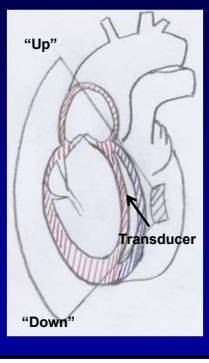
The ‚normal' heart: the patient

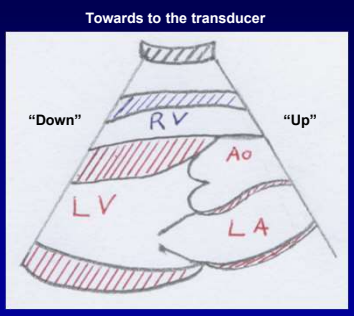
29 years old female patient presented to our clinic. She is confirmed to harbor the Fabry's disease gene in a heterozygous manner. She has a single sign for the Fabry's disease: anhydrosis (lack of sweating). The goal of her visit is to assess the potential cardiac complications.

The Fabry's disease is an X-linked storage disease. The mutation is resulting in the lack of alpha-galactosidase. As a result globotriaosylceramide is accumulating in the blood vessels besides to other organs. The incidence of the Fabry's disease is 1:40-120 000. The symptoms are serious in homozygous and hemizygous individuals, while heterozygous individuals may have no apparent symptoms. Detailed examination of the individuals harboring the Fabry's disease gene is routine procedure, because of the occasional cardiovascular complications. Proper diagnosis is required for the appropriate treatment of the disease.

Symptoms include: Raynaud's disease like neuropathic pain, angiokeratomas, anhidrosis, kidney failure, cardiomyopathy, etc.

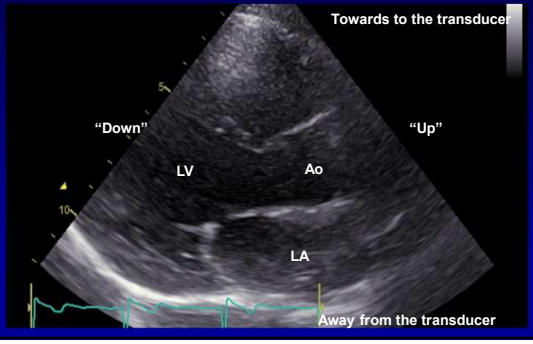
Parasternal long axis view



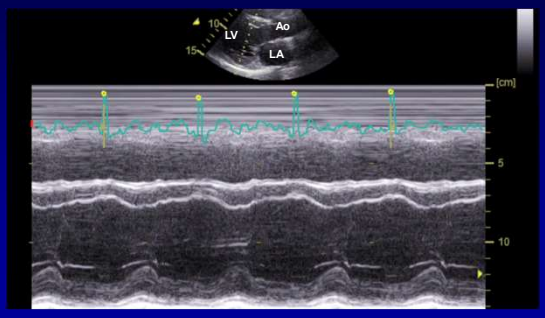


Drawn by Huynh Thanh An

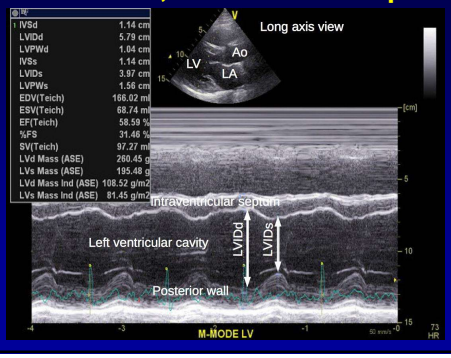
The ‚normal' heart: long axis view



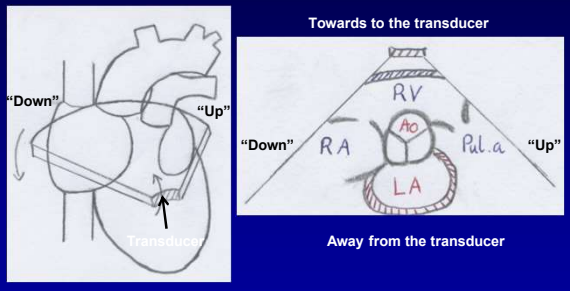
Long axis view, M-mode



The ‚normal' heart: long axis view, M-mode Ejection fraction, ventricular morphometry

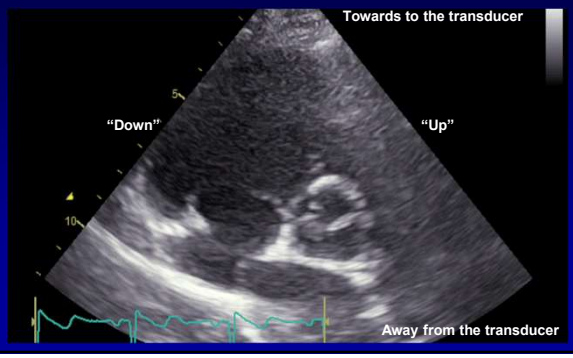


Short axis view: aortic valve

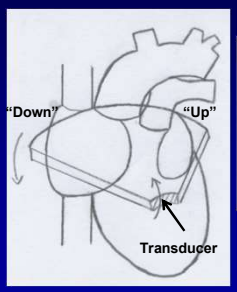


Drawn by Huynh Thanh An

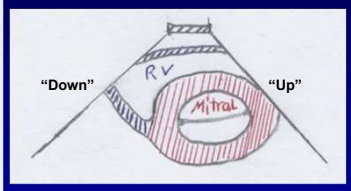
The ‚normal' heart - short axis view: aortic valve



Parasternal short axis view: mitral valve



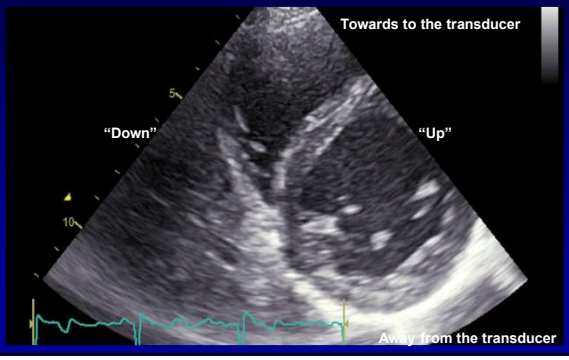
Towards to the transducer



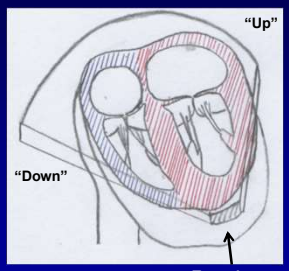
Away from the transducer

Drawn by Huynh Thanh An

The ‚normal' heart - short axis view: mitral valve

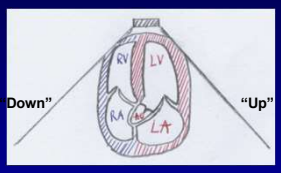


Apical view: 5 chambers



Transducer

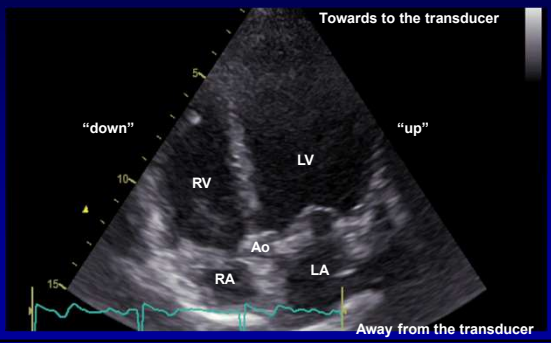
Towards to the transducer



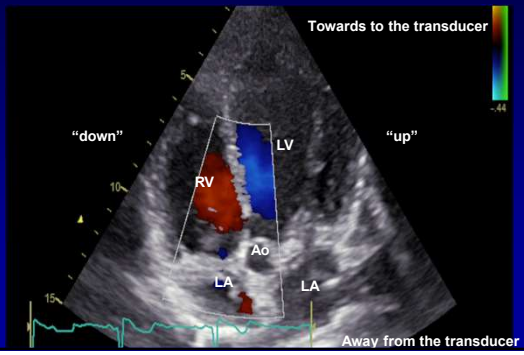
Away from the transducer

Drawn by Huynh Thanh An

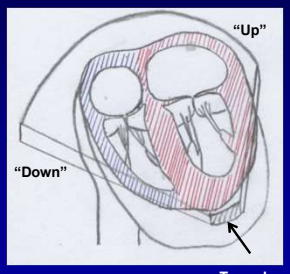
The ‚normal' heart: apical view: 5 chambers

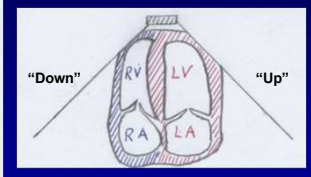


The ‚normal' heart - apical view: 5 chambers, Color Doppler



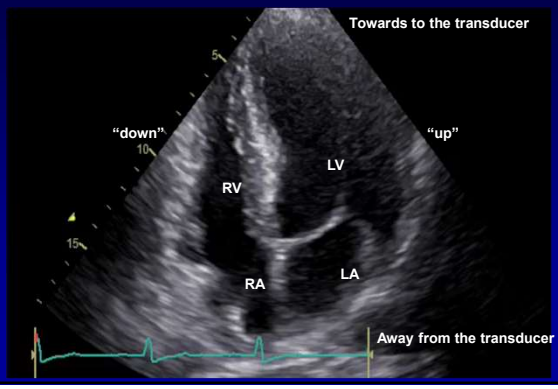
Apical view: 4 chambers



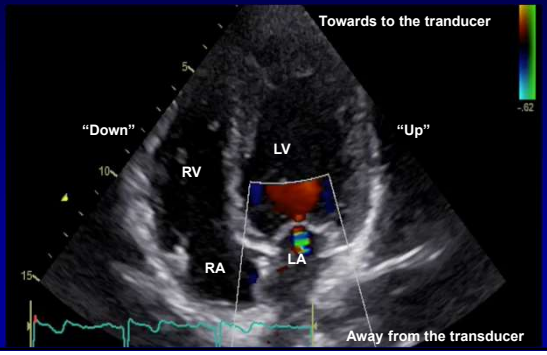


Drawn by Huynh Thanh An

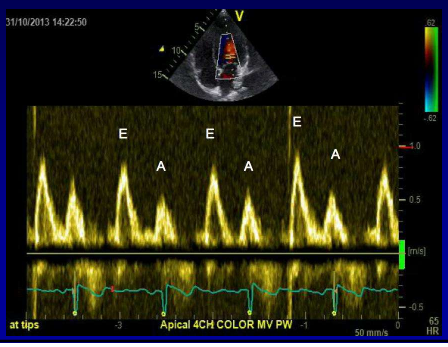
The ‚normal' heart - apical view: 4 chambers



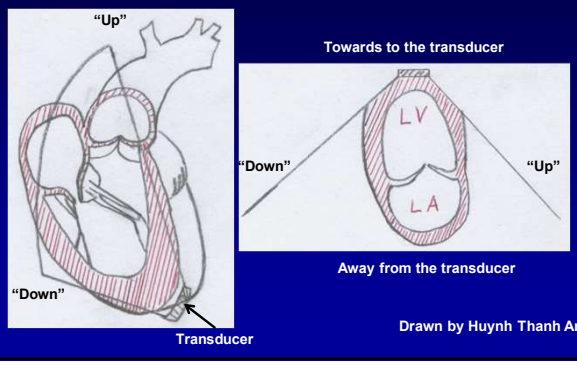
The ‚normal' heart - apical view: 4 chambers, Color Doppler



The ‚normal' heart: apical view: 4 chambers, Doppler, Diastolic function: E/A

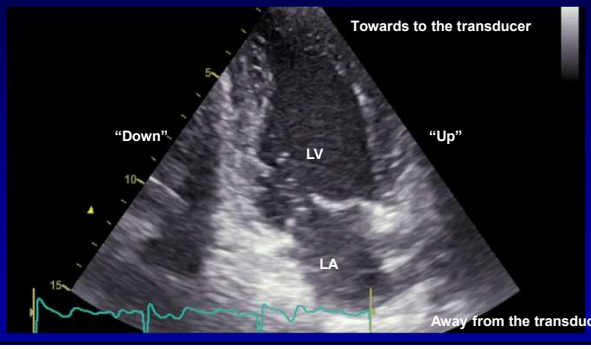


Apical view: 2 chambers

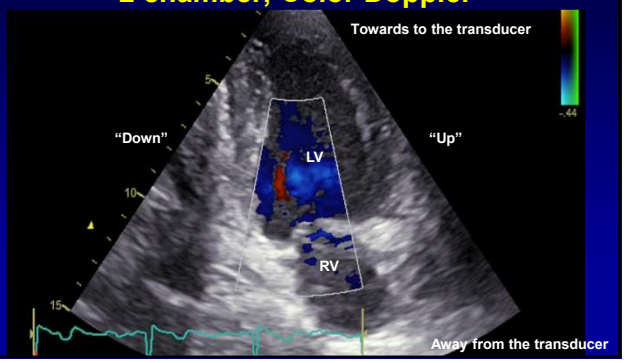


Drawn by Huynh Thanh An

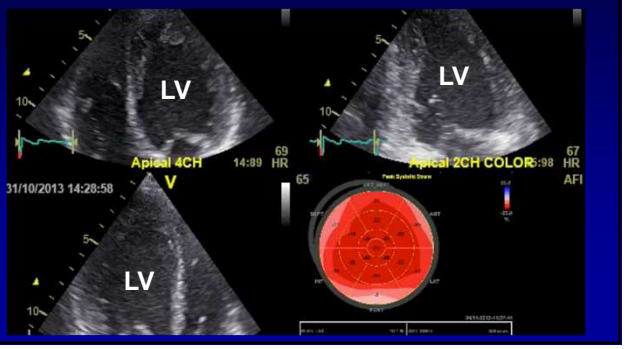
The ‚normal' heart - apical view: 2 chamber



The ‚normal' heart - apical view: 2 chamber, Color Doppler



The ‚normal' heart - apical view: speckle tracking



Aortic valve stenosis: the patient

67 years old male patient visited the Emergency Department with fainting (syncope). The neurological causes of fainting (stroke, brain ischemia) were ruled out, and it was revealed that the patient experiences breathlessness and chest pain upon moderate exercise (physical activity). Moreover, the examiner observed murmur.

The aortic valve stenosis is a disease, which manifests in the form of calcifications of the aortic valve. In most of the cases the aortic valve consists of three leaflets (hence tricuspid), but in some cases (1-5% of the population) it only contains two leaflets (bicuspid). In these latter cases the occurrence of aortic calcification is much higher. Calcification usually occurs at the age of 70-80 for the tricuspid valves and considerably earlier (40-50 years old population) for the valves with two leaflets. In general, the aortic valve stenosis, which is the most common form of valve diseases, occurs at an average age of 65-70 years.

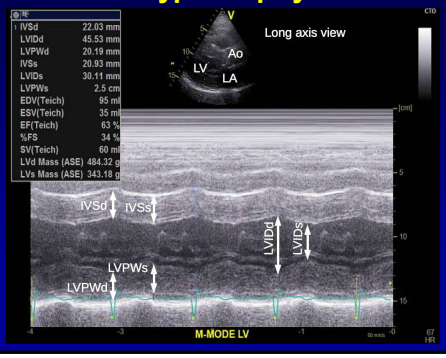
Aortic valve stenosis: the patient

Calcification of the aortic valve narrows the opening of the aortic valve (orifice) and forms a barrier in the left ventricular outflow. The normal range for the surface of aortic valve orifice is 3-4 cm2 (Table 1). Aortic valve replacement or reconstructive surgery is usually indicated when this is narrowed below 1,0 cm2.

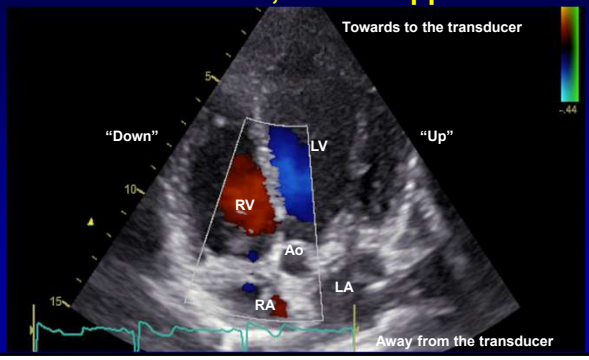
As a result of the stenosis of the aortic valve the left ventricular outflow surface is limited. As a result the left ventricle is generating a higher pressure to overcome this obstacle and to maintain the cardiac output. This results in systolic left ventricular overload. The accommodation to this elevated pressure is to increase the muscle mass, which leads to concentric cardiac hypertrophy. In a later stage of the disease, the cardiac chamber may dilate, in which case the ventricular wall thickness and the ejection fraction decrease (see systolic heart failure later).

The easiest sign for aortic valve stenosis is murmur, but its diagnosis is based on echocardiography.

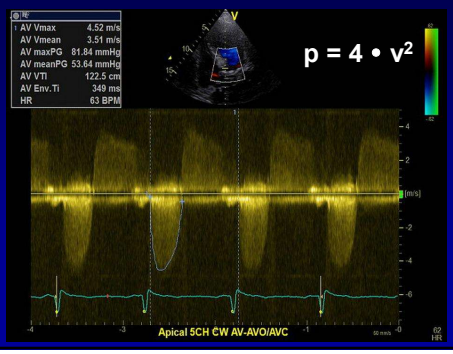
Aortic valve stenosis - long axis view, M-mode Hypertrophy



Aortic valve stenosis: apical view, 5 chambers, Color Doppler



Aortic valve stenosis: apical view, 5 channel, Doppler
Hyperkinetic blood flow and pressure gradient



Diastolic heart failure: the patient

59 years old female patient visited the Department of Pulmonology. Her complaints were breathlessness and coughing. There were no signs of pulmonary diseases, but it was revealed that she has occasional edema in the legs and she is suffering from hypertension for a decade or so. She was examined for these symptoms at our clinic (Cardiology).

The symptoms of heart failure often overlap with pulmonary diseases, since there is insufficient oxygen supply in both cases. The diagnosis of heart failure is based on decades old subjective criteria, originally published by the New York Heart Association (NYHA):

Risk factors for diastolic heart failure consist: hypertension (especially without proper management), diabetes, smoking, sedentary life style, myocardial infections.

There is a dominant role for atrial contraction in the filling of the left ventricle. Hence these patients are more sensitive to atrial fibrillation and their symptoms can significantly worsen on the onset of atrial fibrillation. As a consequence these patients are usually complaining (and showing up in the health care system) when atrial fibrillation occurs. The diagnosis of diastolic heart failure is based on the echocardiographic evaluation of the cardiac function. This disease is usually called as Heart Failure With Preserved Ejection Fraction, according to the echocardiographic diagnostic criteria.

Heart failure grades

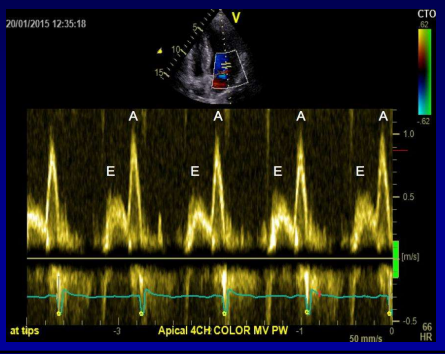
NYHA I: There are no complaints in the case of regular activity, but breathlessness, angina occurs upon heavy physical work (exercise).

NYHA II: Mild symptoms upon regular physical activity (shortness of breath, fatigue, angina).

NYHA III: The patient is without symptoms upon rest. Even moderate physical activity causes symptoms (such as walking for 50 m or so).

NYHA IV: Constant severe symptoms even upon rest. These patients are usually bedridden.

Diastolic heart failure: apical 4 chamber view, Doppler, Reduced E/A ratio: relaxation disturbance



Systolic heart failure: the patient

67 years old men visited our clinic. He had edema in the legs and were treated myocardial infarction a decade ago, which was successfully treated by opening of the coronary artery and stent implantation at that time. He had edema in the legs now. However there were some problems with the compliance of the patient, when his hypertension was treated in the past decade.

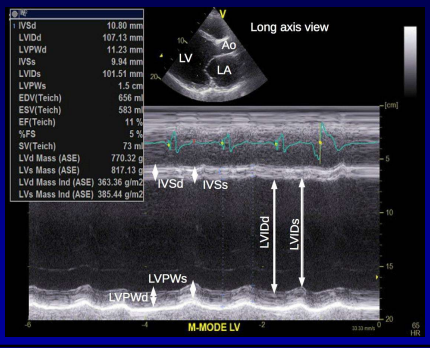
The symptoms of the systolic heart failure are similar to that of diastolic heart failure (see NYHA grades). It can be differentiated by echocardiographic examination. The proper diagnosis is of particular importance, since the treatment options are quite different, although the life expectancy is similar (5 year mortality is about 50%). The systolic heart failure can be successfully treated with inhibitors of the renin-angiontensin-aldosteron system, beta-blockers or Ca2+ channel blockers. These drugs are ineffective in patients with diastolic heart failure. It is therefore important to differentiate between these pathologies.

Systolic heart failure: the patient

The reason of heart failure is the decreased cardiac output. This is the result of insufficient contraction in the case of systolic heart failure. This is often the consequence of dilated ventricular chamber morphology and decreased ejection fraction.

The pathomechanism of ventricular dilation is complex. In most of the cases this is the result of accommodation for the high intraventricular pressure. During the accommodation the heart first hypertrophied then the wall is thinned in parallel with the enlargement of the ventricular chamber. This process is called “remodeling” on the lectures. Nonetheless, this dilated state can be the consequence of alcoholism, autoimmune disorders, and inherited forms are also known.

Systolic heart failure: long axis view, M-mode
Decreased ejection fraction, chamber dilation



Hypertension: the patient

44 years old men visited our clinic. His complaints include that occasionally he feels headache and under these periods his blood pressure level reaches 140/90 mmHg values. An extensive effort was made to clarify the primary reason behind his hypertension (kidney function, endocrine system, ECG and echocardiographic parameters were tested). His blood pressure was 162/87 mmHg at the visit.

The diagnosis of hypertension relies on the measurement of blood pressure. It needs to be more than 140 mmHg systolic (systolic hypertension), OR 90 mmHg diastolic values (diastolic hypertension) at least twice in a week under resting, relaxing conditions. There is no difference in the view of the diagnosis if only a single or both blood pressure values are elevated.

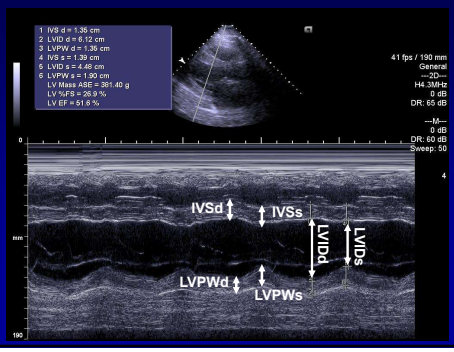
Surprisingly there are no obvious reasons for hypertension in the vast majority of the patients (95%). These patients are suffering from secondary (essential) hypertension. The goal of the treatment is therefore to lower the blood pressure into the normal range (below 140/90 mmHg). Treatment with a single drug is rarely sufficient; in most of the cases combination therapy is indicated. In the 5% of the hypertensive cases the reason of hypertension is clearly identified. In these cases the disease leading to hypertension should be treated.

Hypertension: the patient

Hypertension is called as “silent killer”. It has a single sign: high blood pressure, which can not be felt in most of the cases. Nonetheless, hypertension is a major risk factor for cardiovascular diseases, such as stroke, myocardial infarction and peripheral artery disease (besides others). These diseases represent the major reason of death in many developed countries. Proper treatment of hypertension is therefore a major challenge for the health care system, which has a huge impact on the society.

Patients are required to take pills until their death in most of the cases after development of hypertension (if the reasons are unknown). The life expectancy is reduced by about 2-25 years without proper management of the disease.

Hypertension: long axis view, M-mode Concentric hypertrophy



Final exam test bank – Int-1.155

What kind of examination would you perform to certificate or exclude the diagnosis?
A patient arrives with fever and dyspnoe into the ambulance. By the physical examination they observe, that the heart is bigger in the left side. During the chest X-ray they do not see the pulsation of the contour of the heart. By auscultation we can hear soft systolic murmur above the apex.

A) test-punction and bacterial examination

B) chest X-ray

C) transthoracic echocardiography

D) transesophageal echocardiography

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Final exam test bank – Int-1.161

To confirm the diagnosis what kind of device examination should we perform?
A 64-year-old man has had hypertension in his anamnesis for decades, he does not take any pills. He started smoking when he was 21 years old. He has been short of breath because of charging for 3 months. He has had urine several times at night for a month. Both of his legs have been swollen by the evening for a week. He has been taken to the internal medicine department at night because of strong shortness of breath during sleeping.

1) echocardiography
2) treadmill exercise test
3) ECG
4) pulmonary scintigraphy

A) 1st, 2nd and 3rd answers are correct
B) 1st and 3rd answers are correct
C) 2nd and 4th answers are correct
D) only 4th answer is correct
E) all of the answers are correct

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Final exam test bank – Int-1.61

Echocardiographic findings of aortic stenosis:

1) the end-diastolic diameter of the left ventricle is not significantly enlarged

2) concentric left ventricle hypertrophy can often be seen

3) the left atrial diameter can be abnormally large

4) a pathologic transvalvular gradient can be measured at the level of the aortic valve with Doppler ultrasound

A) Answers 1, 2 and 3 are correct
B) Answers 1 and 3 are correct
C) Answers 2 and 4 are correct
D) Only answer 4 is correct
E) All of the answers are correct

Final exam test bank – Int-1.102

The aortic stenosis cause increased left ventricle load, because of that the consequence is left ventricular hypertrophy.

A) Both of them are correct, there is causal relationship between them

B) Both of them are correct, but there is no causal relationship between them

C) The first part is correct, the second one is wrong

D) The first part is wrong, the second one is correct

E) Both of them are incorrect