above the pulmonary artery. The second sound is weakened in consequence of deformation of the pulmonic valve.

3.9 Cardiomyopathies

Cardiomyopathies represent a group of heterogenous diseases of the heart which involve a chronic, idiopatic pathologic process inflicting especially the cardiac muscle. The group of cardiomyopathies includes neither ischemic nor inflammatory impairment of myocardium.

The term cardiomyopathies (respectively myocardiopathies) has currently a significantly different meaning in comparison with its original content. It was a tradition to distinguish coronary and noncoronary cardiomyopathies. Coronary cardiomyopathies included diffuse ischemic impairment of the cardiac muscle. Noncoronary cardiomyopathies included nonischemic impairments of myocardium, namely those with unknown etiology (primary cardiomyopathies), or secondary affliction of the cardiac muscle in the frame of a particular extracardiac disease (secondary cardiomyopathies).

Nowadays cardiomyopathies are comprehended as noncoronary diseases of the cardiac muscle with unclear etiology. If the myocardium is afflicted in the frame of extracardiac primary disease we speak about specific diseases of the cardiac muscle (these are not included into cardiomyopathies).

Currently the classification of cardiomyopathies is accepted including three basic types:

- dilating cardiomyopathy
- hypertonic cardiomyopathy
- restricting cardiomyopathy

3.9.1 Dilating cardiomyopathy

Dilating cardiomyopathy is characterized by several typical properties which are however not specific and can occur in different types of heart impairments. Let simultaneous occurrence of more of them, unknown etiology of the particular state of the heart and an echographic finding of dilated heart enable to state the diagnosis of dilating cardiomyopathy. The most important features of this disease include:

- dilatation of the left ventricle, alone, or in connection with dilatation of the left atrium and right compartments of the heart.
- diffuse impairment of the kinetics of the left ventricular walls (sometimes the same can be applied by the right ventricle)
- significant reduction of systolic cardiac function
- formation of thrombi in hypokinetic compartments of the heart with subsequent embolization
- impairments of cardiac rhythm which may be of malign character (ventricular tachycardia, ventricular fibrillation)
- heart failure

The given set of signs originates in consequence of primary impairment of cardiac contractility. In consequence of impaired contractility the pumping function of the heart decreases. The ejection fraction decreases from normal 60–70 % to extremely low values – often just 15–20 % and first symptoms of left ventricular failure appear. The right ventricle can fail in consequence of primary failure of the left ventricle by propagation of pressure into the pulmonary artery, or it can fail at the beginning of the disease simultaneously with the left ventricle. In sporadic cases the left ventricle begins to fail as first.

Marked dilatation of ventricles yields mitral or tricuspidal insufficiency in consequence of dilatation of the left atrioventricular valve annulus. These valvular defects lead to further volume overload of the heart and enhance heart failure.

Thrombi originate in any of dilated heart compartments in consequence of stagnation of the blood. They may tear off and cause embolism in the arterial bed (in case of their left heart origin) or pulmonary bed (if they come from the right heart compartments). Consumption of ATP increases in the dilated ventricles with increased wall stress, and ectopic foci of electric activity originate. In this way extrasystoles, tachycardia, resp. atrial or ventricular fibrillations occur. In consequence of fibrotic changes

which may inflict also the septum, various degrees of blocks are brought about. Gallop rhythm often develops in hemodynamically overloaded heart.

Despite the intensive experimental and clinical research the cause of dilating cardiomyopathy remains unclear. The histologic picture is characterized by minute focal fibrosis. The latter occurs in many types of chronic impairments of the heart and does not contribute to elucidation of the etiology of contractility impairment. The possible etiologic factors include:

- genetic predisposition
- immunoalterating process
- damage caused by chemical substances (conservation substances, alcohol)
- heavy metals
- hormonal impairments

Dilating cardiomyopathy may develop in the case when reverse potential etiologic factors act together. Chronic alcoholism can serve as an example. Ethylalcohol and its metabolic products have a toxic impact especially on mitochondria reducing thus energy production. Some specific components of alcoholic drinks may also have toxic influence on myocardium. Cobalt which has been used in some countries in order to improve the quality of beer froth is included among such substances. Moreover, chronic alcoholics substitute a major part of their caloric intake by alcohol which brings about the deficit of essencial aminoacids, important vitamins especially those of the B group, and impairment of ion balance. In spite of this cardiomyopathy does nor develop in a majority of alcoholics. Cardiomyopathy develops probably only in persons with a particular genetic perdisposition or those with altered myocardium due to precedent inflammation or immunoalterative process. It is assumed that although the inflammation had healed, the heart became permanently more sensitive to negative external factors (e.g. alcohol, medicaments).

Dilating cardiomyopathy has a progressive character and infavourable prognosis. As the etiology of the disease is not known yet, the therapy is predominantly symptomatic.

3.9.2 Hypertrophic cardiomyopathy

This type of cardiomyopathy is characterized as follows:

- Asymetric hypertrophy of the left ventricle. The left ventricle is usually not diffusely thickened (as in aortic stenosis and hypertension disease), but hypertrophy of a particular part of the septum or left ventricle are developed.
- Expressive impairment of the left ventricular relaxation ability. Deterioration of diastolic function is caused by both the thickening of the musculature and increased mass of connective tissue in the myocardium
- Reduction of the left ventricular cavity in consequence of wall hapertrophy
- Excellent contraction of the left ventricle, the ejection fraction of which is higher than 80 %
- The character of histologic picture of hypertrophic parts. The thickened parts are characteristic by irregular crossing of muscular fibers (so called zig-zag picture) in contrast to parallel course of muscular fibers seen under physiological conditions.

Hypertrophic cardiomyopathy is an autosomally dominant disease. The genetic predisposition however manifests itself solely in some cases. The family histories of patients often yield cases of positive genetic basis where hypertrophic cardiomyopathy is lacking. The genetic basis may manifest itself as a clinical disease providing there is an accord of both the genetic basis and particular external etiologic factors.

The main sign of hypertrophic cardiomyopathy is the hypertrophy of some part of the left ventricular musculature. The diagnosis can be predominantly stated on the basis of echocardiographic examination. Some cases however yield an echocardiographic finding which is not explicit and solely on the basis of family history, imaging examinations and respectively bioptic examination of the myocardium it is possible to build the diagnosis of hypertrophic cardiomyopathy.

Two basic types of hypertrophic cardiomyopathy are distinguished:

1. type with obstruction (formerly called idiopatic hypertrophic subvalvular stenosis)
2. type without obstruction

1. Obstructive type – is characterized by the narrowing of the outflow tract of the left ventricle. As this obstruction is not of permanent character but manifests itself only during systole we refer to functional type of obstruction. Two factors participate in its development:

- Hypertrophy of the proximal part of the interventricular septum. This part of the septum thickens during systole to such an extent that it causes stenosis of the outflow tract of the left ventricle.
- The second factor which participates in obstruction is the systolic anterior movement of the mitral apparatus (systolic anterior motion-SAM). During systole the anterior cusp of the mitral valve and often also the whole mitral apparatus move towards the thickened septum which supports even more the stenosis of the outflow tract of the left ventricle caused by the thickening of the septum.

Pathomechanism of the systolic anterior motion of the mitral valve as well as the impact of this phenomenon on the development of obstruction is a frequently discussed problem. It is assumed that SAM is rather a hemodynamic consequence of the stenotic outflow tract than its cause. Hypertrophy of the septum results in gradient between the left ventricle and aorta during systole. The blood flows faster through the stenotic orifice which results in relative underpressure in comparison with the pressure within the inflow part of the left ventricle. Consequently the whole mitral apparatus (especially the anterior cusp which is located mostly proximally) is being drawn towards the site of underpressure. The nearer is the mitral valve to the septum, the more expressive is the obstruction, the faster is the blood flow and the underpressure pulling the mitral valve toward the septum grows. Consequently the anterior motion of the mitral valve becomes more expressive. The presented facts imply that the mitral anterior motion is rather a concomitant sign and a factor supporting the development of obstruction. The primary factor causing obstruction is the thickening of the proximal septum. The fact which supports the hypothesis is that the obstruction does not develop in those types of hypertrophic cardiomyopathiy in which hypertrophy of the septum is lacking.

Hypertrophy of the septum, respectively of further parts of the left ventricle does not develop on the basis of obstruction with subsequent hamodynamic overload. It is a genetically determined thickening of the left ventricular walls. The developed hypertrophy thus results in specific anatomical and functional changes in the outflow tract of the left ventricle, which is ultimately manifested as obstruction.

2. Hypertrophic cardiomyopathy without obstruction is characterized by hypertrophy of various parts of the left ventricle. This type of disease is not accompanied by obstruction of the left ventricular outflow tract.

3.9.2.1 Pathomechanism of clinical symptoms

The clinical picture of the obstructive hypertrophic cardiomyopathy resembles aortic stenosis: stenocardia, collapse, heart failure, sudden death. Pathomechanism of these signs is similar to that of the mentioned valvular disorder.

Auscultation reveals a rough ejection murmour sound in the second half of systole which is in comparison with aortic stenosis localized parasternally on the left and in the area of the apex.

In the recent years studies have appeared which revealed the so-called hypertrophic cardiomyopathy without hypertrophy. The heart of those patients is not hypertrophic. They have however a positive family history and the histologic picture of a part of left ventricle is characterized by typical crossing of the muscular fibres. It is not clear yet as to whether a latent - histologic form of disease is involved or whether each clinical disease is initiated regulary with histologic changes.

The prognosis is uncertain. Hypercontractility of hypertrophic areas in some patients decreases to, or below normal and also the ejection fraction decreases. The heart does not dilate, but the deterioration of systolic abilities manifests itself by increased intraventricular pressure and pulmonary blood stagnation.

3.9.3 Restrictive cardiomyopathy

This group includes two diseases. Endomyocardial fibrosis and fibroelastosis of the myocardium.

3.9.3.1 Endomyocardial fibrosis

The disease occurs in tropical regions at the equator. It is characterized by the thickening of endocardium in consequence of proliferation of callagenous fibres. The changes are localized at the beginning in the inflow parts of either the left or right ventricle, later the thickening of endocardium can inflict a larger part of one or both ventricles.

The furher development yields scar formation and retraction of connective tissue of endocardium and adjacent parts of myocardium. Three essential changes take place:

- reduction of the left or right ventricular cavity
- reduction of elasticity and thus also the impairment of diastolic abilities of ventricles
- retraction of the pathological collagenous tissue of chordae and papillary muscles cause incomplete closure of the mitral and/or tricuspidal valves and the development of mitral or tricuspidal regurgitation

Although the fibrotic rebuilding of both endocardium and adjacent myocardium does not alter the ability of contraction, it reduces the end-diastolic volume. Currently the end-diastolic pressure in ventricles elevates. The blood which in consequence of restriction does not reach the ventricles, stagnates in the atrii. The atrii become hypertrophic and finally they dilate. The dilatation of atrii is brought about not only by restriction of diastolic filling of ventricles, but also by mitral and tricuspidal insufficiency. Ultimately the elevated pressure is propagated into the pulmonary bed causing thus dyspnea. The morphologic picture of the heart in a later stage of this fidease is characterized by small ventricles and dilated atrii. Hemodynamic indices include a conspicuously elevated end-diastolic pressure. The systolic function is proportionally well maintained, the diastolic function is essentially deteriorated. In consequence of high ventricular pressure there is mitral and tricuspidal regurgitation even when the valvular insufficiency is not pronounced. Large thrombi develop often in the ventricles, reducing thus the ventricular cavity and contributing to the restriction of ventricular filling.

It is assumed that endocardial fibrosis is an acquired disease which develops on the basis of infectious or immunoalterative inflammation.

3.9.3.2 Fibroelastosis of myocardium

It is an inborn disease in children. It is characterized by a diffuse proliferation of collagenous and elastic connective tissue of endocardium of the entire left or right ventricle. Similarly as in the previous disease fibroelastosis of myocardium manifests itself by symptoms of restricted ventricular filling.

3.9.4 Specific diseases of myocardium (secondary cardiomyopathies)

Impairment of myocardium can develop as a secondary manifestation of extracardial diseases.

- **Endocrine**: hyperthyreosis, hypothyreosis, Cushing's syndrome, Addison's disease, hyperparathyreosis and hypoparathyreosis, acromegaly, foechromocytoma and diabetes mellitus.
- **Neurologic, neuromuscular diseases and collagenoses**: progressive muscular dystrophy, Fridreich's ataxia. disseminated lupus erythematosus, dermatomyositis, and diffuse scleroderma.
- **Metabolic diseases**: amyloidosis, haemochromatosis, glycogenosis
- **Nutritional diseases**: beri-beri, kwashiorkor.
- **Haematologic diseases**: anemia, polycytemia
- **Pharmacies**: adriamycin, cyclophosphamid, and heavy metals

Various etiologic factors evoke secondary cardiomyopathies by various pathomechanisms. Haemodynamic consequences can include deterioration either of the contractile ability (e.g. hypothyreosis) or relaxation ability (e.g. haemochromatosis, glycogenosis, sarkoidosis, diabetes mellitus), respectively deterioration of both functions. Some diseases even increase the contractile function of the heart and the relaxation ability of myocardium may remain maintained

(hyperthyreosis, feochromocytoma). The heart impairment in these diseases is caused in consequence of long-term increased ineffective performance which results in depletion of macroergic phosphates and sometimes even in the development of numerous necroses.

3.10 General adaptation syndrome – stress

The theory of stress belongs unambiquously to the greatest achievements in medecine of the 20 th century. However, this problem is not analyzed with adequate attention in textbook literature. The general adaptation syndrome – stress is a specific disease entity and terefore it seeks its place in internal medicine with difficulties. The textbooks of pathologic physiology traditionally included stress into their general parts. It coincided with the fact that not a single, but several systems participate in the stress reaction and consequently the entire organism is altered.

Without the need of appologizing it is necessary to admit that the adaptation syndrome has appeared at the brink of attention of both pedagogues and students. One of the most complex theories of modern medecine represented for a long time an untraced site in the system of medical education and postgradual study and therefore it has not become such a diagnostical and therapeutical instrument in the daily medical practise as it could have become due to its significance and impact.

Especially the facts mentioned above lead us to including the theory of stress into the tuition of cardiovascular system. The cardiovascular system has a crucial role in adaptation response of organism to stressor. Despite the central, i.e. regulatory and coordinatory function of nerves and hormones, the major effective organ is the cardiovascular system. The heart and vessels deliver the blood which is rich in oxygen and substrates in adequate amount to organs which perform the greatest activity during stress.

When presenting the stress reaction it is not our aim to specificate it. The reactions of the cardiovascular system to physical or psychical overload, heat, pressure, or gravitation differ according to the evoking factor. The development of all subsequent reactions is however very similar. Therefore these situations are not individually presented. We pay increased attention to the general term of adaptation as well as to possible negative consequences of an extensively or frequently repeated reaction to overload.

3.10.1 Adaptation

Man, being a psychosomatic entity is in comprehension of modern biology an **open system**. In contrary to the entirety per se which represents merely a conglomerate of entities there exist dynamic and at the same time constant hierarchically arranged relations of super and subordination between the components of the system. Organism is comprehended as an open system as its borders are sufficiently firm not to be diffused into the surrounding space, but at the same time partially permeabile, thus allowing the substances, energy and information pass in both directions. An organic system accepts substances rich in energy and excludes products with lower amount of energy. This energy gradient is utilized for internal performance of an organism. **Entropy, i.e. measure of derangement** decreases during the process of growth and maturation, afterwards its constant level is maintained and at the old age the entropy increases. An organism achieves the maximal degree of disorganization after death. At that time, however, the hierarchical manner of arrangement of its subsystems, as well as active exchange of substance and energy with the surrounding space cease to be functional.

One of the basic characteristics of organisms which secure a relative constancy and independence from changes of environment is the capability of autoregulation. The term regulation refers to minimalization of the difference between the actual values and the required value of the regulated variable, namely on the basis of investigation of the above mentioned gradient. Phylogenetically lower animals yield chemical regulation. Higher organisms yield humoral regulation which is allied to chemical regulation, and the phylogenetically youngest nervous regulation which supervises all levels of regulation. Both humoral and nervous regulation are basically of chemical character (hormones, mediators).

While the number of impulses from the exter-