

***Atherosclerosis and arteriosclerosis.
Ischemic heart disease.
Hypertension and arteriosclerosis.***

Atherosclerosis and arteriosclerosis.

Definition

- Atherosclerosis- chronic disease which arises up as a result of violation of fatty and albuminous exchange.
- On atherosclerosis is “various combinations of changes of internal membrane of arteries,
- which show up as a focus laying of lipids,
- difficult connections of carbohydrates,
- elements of blood and circulatory in it matters,
- formation of connecting tissue and laying of calcium”.
- Atherosclerosis damages vessels elastic and elastic-muscular types.
- After prevalence illness occupies the first place in cardio-vascular pathology.
- Lately it collected character of epidemic, especially among the citizens of highly developed countries.
- It is met mainly for the people of mature age - after 30-35.

Etiology.

- It is a polyetiologic disease.
- There is plenty of risk factors which are instrumental in the increase of level of atherogenic lipoproteins in blood and to penetration of them in the wall of vessel:
- arterial hypertension,
- diabetes mellitus,
- obesity,
- hypokinesia,
- smoking,
- hyperlipidemia and dislipoproteinemia,
- inherited inclination,
- age,
- sex (more frequent meets for men),
- psychoemotional overstrain and etc.

Etiology

- There are the followings theories of development of atherosclerosis :
- infiltrative theory of Anichkov,
- nervously metabolic theory of Myasnikov,
- immunological theory of Klimov and Nagornev,
- viral theory,
- gerontology theory of Davidovskiy,
- thrombogenic theory of Rokitansky.

Pathogenesis

- Pathogenetic essence of atherosclerosis consists in the focus laying in intima of arteries of so-called atherogenic lipoproteids in reply to the damage of endothelium.
- Atherogenic Lipoproteids are considered to be lipoproteids of very low and low closeness, which contain the large supply of cholesterol (to 45%) and little albumen.
- Lipoproteids of high closeness, opposite, a protein (55%) and comparatively little cholesterol have much (16%).
- They execute an antiatherogenic function, that prevent development of atherosclerosis.

Pathological anatomy

In development of atherosclerosis select four stages –

- prelipid,
- stage of lipid spots,
- stage of fibrosis plaques and

□stage of the complicated defeats (ulceration, calcinosis, thrombosis).

Prelipid stage

- is characterized with such processes, as a loss of glycocalix - protective polysaccharide layer of endotheliocytes,
- expansion of intraendothelial cracks,
- activating of endocytosis in endothelial cells.
- Intimae swells up.
- In subendothel space begin to penetrate lipoproteids from plasma of blood in growing amounts.
- Lipoproteids of high closeness counteract converting of macrophagocytes into foamy cells.
- They easily penetrate at intimae, saturated cholesterol and similarly easily go back into blood. Macrophagocytes have on the surface specific receptors for lipoproteids of high closeness.

Prelipid stage

- Another characteristic of morphological feature of atherogenesis is proliferation of cells of smooth muscles in intimae of vessels.
- Myocytes migrate here from the middle membrane of arteries (media) under act of factors of chemotaxis, and reproduction of them depends on the factors of growth - thrombocytic, fibroblastic, endothelial. Myocytes which migrated at intimate and began there to propagate oneself transform from retractive cells on metabolic active.
- Without regard to absence of scavenger -receptors, they acquire property to take in modified lipoproteids and accumulate ethers of cholesterol. Foamy cells appear also from them.

stage of lipid spots

- Lipid spots (strips) appear in the different departments of the arterial system, but before in all in an aorta.
- From cellular elements foamy cells, T-lymphocytes and fibres of smooth muscles, prevail for them.
- On this stage ethers of cholesterol are mainly in cells.
- Around there is insignificant excrescence of connecting tissue.
- Lipid spots do not hinder a blood stream.
- Foamy cells, overloaded a cholesterol, collapse in course of time, and cholesterol is outpoured in out of cellular space. It irritates surrounding tissues as extraneous body and causes brief cellular proliferation at first, and afterwards - making progress as fibrosis. The accumulations of foamy cells and out of cellular lipids, bedding between elastic fibres, make light intima. Glycosaminglycanes are put aside in it, γ -globulin, fibrin.

stage of fibrosis plagues

- Fibrous plagues consist of amorphous mass, which tailings of elastic and collagenic fibres, cholesterol, enter in the complement of, foamy cells are not blasted.
- If in plagues the processes of disintegration prevail with formation of necrotic masses, such plagues name atheromatosis. Tissue detritus which is included in their composition reminds maintenance of retentsiy oil-gland - atheroma.
- Foamy cells, lymphocytes, plasmocytes, newformed vessels, accumulated on periphery of plague.
- From lumen of vessel is marked off hyalinised by connecting tissue (overlay of plague). Complications begin from this stage.

stage of the complicated defeats (ulceration, calcinosis, thrombosis).

- Ulceration of plagues - is also the frequent enough phenomenon.
- An ulcer has unequal edges, the bottom of it is formed by a muscular layer or adventitia.
- The defects of plagues are often covered by blood clots.
- If atheromatous masses get in a bloody river-bed, they become the reason of embolism of brain and other organs.

□This microscopic cross section of the aorta shows a large overlying atheroma on the left. Cholesterol clefts are numerous in this atheroma. The surface on the far left shows ulceration and hemorrhage. Despite this ulceration, atheromatous emboli are rare (or at least, complications of them are rare).

stage of the complicated defeats (ulceration, calcinosis, thrombosis).

Another complication of fibrous plaques – is liming (atherocalcinosis). This process is complete of atherosclerosis.

Salts of lime are put aside in atheromatous masses, fibrous tissue and intermediate matter between elastic fibres.

Plaques collect stony consistency.

The focus of calcinosis are localized mainly in an abdominal aorta, coronal arteries, arteries of pelvis and thighs.

clinic-morphological forms of atherosclerosis

Depending on localization of atherosclerosis in a that or other vascular pool select followings clinic-morphological his forms:

atherosclerosis of aorta,

atherosclerosis of coronal vessels of heart,

atherosclerosis of arteries of cerebrum,

atherosclerosis of arteries of kidneys,

atherosclerosis of arteries of intestine,

atherosclerosis of arteries of lower limbs.

Atherosclerosis of aorta

On preparations expressly determined all of the stages of atherosclerosis:

yellow spot and ribbon,

fibrous plaques,

atheromatous,

ulceration,

sclerosis and calcinosis.

At the initial displays of atherosclerosis (yellow spots and ribbons) aorta is not deformed.

Intimae is yellow. Pay attention, that yellow spot and ribbon located mainly near places of origin of arteries.

This high magnification of the atheroma shows numerous foam cells and an occasional cholesterol cleft. A few dark blue inflammatory cells are scattered within the atheroma.

Atherosclerosis of aorta

yellow spot and ribbon located mainly near places of origin of arteries. At presence of atheromatous the internal surface of vessel has an unequal kind as a result of presence of plural yellow explosions. Most atheromas had character of ulcers.

Atherosclerosis of aorta

Thrusting out of yellow correspond to atheromas, white - as a result of development of connecting tissue - atherosclerosis. Most atheromas had character of ulcers. Such ulcers of internal surface of aorta are the place of formation of blood clots and can be the source of thromboembolisms.

Atherosclerotic nephrosclerosis

A kidney is dense, surface of largeneven with plural involvements and presence of the thin-walled cysts.

Here is an example of an atherosclerotic aneurysm of the aorta in which a large "bulge" appears just above the aortic .Most such aneurysms are conveniently located below the renal arteries so that surgical resection can be performed with placement of a dacron graft.

This large abdominal atherosclerotic aortic aneurysm below the renal arteries at the right and above the bifurcation at the left has been opened to reveal abundant layered mural thrombus within the aneurysm.

Infarcts of spleen

Gangrene of thin bowel

Wall of bowel is black. In transparent vessels which blood supply bowel, are evidently red obturative blood clots.

."Gangrene of the Intestine".

Pay attention to the changes in the color, surface of intestine, extent of necrotic tissue, texture.

Atherosclerosis of mesenterial artery

Atherosclerosis of mesenterial artery with an obturative thrombosis

A gangrene of foot at atherosclerosis of vessels of lower limbs

On the skin of foot the area of black is expressly determined with maceration. Such changes in tissues of foot arose up as a result of stopping of blood supply which is complication of atherosclerosis of arteries of leg.

Hypertensive illness (HI) or essential hypertension

is a chronic disease with the protracted and proof increase of arterial pressure.

Symptomatic hypertension

arise up at the diseases of the nervous system, kidneys, vessels.

Distinguish also types of symptomatic hypertension:

kidney (nephrogenic, renovascular),

endocrine (illness/syndrome of Icenko-kushing, second aldosteranism, pheochromocytoma),

neurogenic (trauma, tumor, abscess, hemorrhage in a cerebrum, defeat of hypothalamus and brain),

vascular (coarctation of aorta, other anomalies of vessels, polycytemia).

Etiology and pathogenesis of hypertensive illness

fully is not found out.

Important place is in the origin of illness taken disorders of adjusting of vascular tone (Lung, Myasnikov) is illness of unreacting emotions,

and also surplus use of kitchen salt in a meal,

which is combined with genetic propensity to hypertension.

It is possible to select among the mechanisms of development of HI: nervous, reflex, hormonal, kidney, inherited.

All of influencing which are able to promote the cardiac troop landings or peripheral resistance or the first and the second simultaneously can be considered the etiologic factors of hypertensive illness.

To major such belong from them: increase of volume of plasma, increase of the cardiac troop landings, hyperactivity of the sympathetic nervous system, violation of kidney functions.

Sympathic hyperactivity -is one of the strongest factors of development of essential hypertension.

This state affects function of some organs which can be considered to be the targets of the sympathetic influencing. Except for a heart, arterioles, veins and kidneys belong here.

The pathological anatomy of HI

depends on its motion which can be of high quality and malignant.

Select three clinic-morphological stages –

preclinical or transient,

stage of widespread changes of arteries, or organic,

and the stage of the second changes, or organ.

The transient (functional) stage

clinically shows up the periodic increase of arterial pressure,

and morphologically - by the hypertrophy of muscular layer and hyperplasia of elastic structures of arteriole,

spasm of arteriole and

moderate compensate hypertrophy of the left ventricle of heart.

compensate hypertrophy of the left ventricle of heart.

The stage of widespread changes of arteries

is characterized by constantly promoted arterial pressure.

Walls of shallow arteries and arterioles are in a state of proof reduction and hypoxya.

- Their penetrating rises. Plasma impregnates the structures of vascular walls (plasmorrhagia), and the last are destructed. Elements of destruction, and also protein and lipids of plasma are eliminated through a wall by resorption, but it, as a rule, is incompleated, that results in development of **hyalinosis and arteriosclerosis**.
- A vascular wall is thickened, and lumen of arteriole becomes narrower.
- In large arteries, unlike the changes of arteriole described higher, elastofibrosis develops and atherosclerosis. Elastofibrosis is a compensate answer for proof hypertension as hyperplasia and breaking up of internal elastic membrane of vascular wall. Development of atherosclerosis is related to destruction of vascular wall, accumulation of cholesterol and promoted arterial pressure.
- *The typical clinic-morphological display of this stage is a hypertrophy of left ventricle of heart, and also dystrophy and necrobiosis of cardiomyocytes.*
- *The stage of the second organ changes*

- is characterized by the destructive,
- atrophy and
- sclerotic changes of internal organs.

□ heart

- There is diffuse small focus cardiosclerosis in the hypertrophied myocardium
- kidneys
- in kidneys arteriosclerotic nephrosclerosis develops or initially wrinkled kidneys which
- are symmetric diminished here,
- dense consistency,
- with shallow tuberositas on a surface,
- thickening of cork layer on a cut.
- At a microscopy the bulge of afferent arteriole appears with expressed them by hyalinosis,
- glomerules of sclerous and hyalinous,
- tubules are obsolete,
- stroma is scleroused.

Malignant clinical course of hypertensive illness

- For the *malignant clinical course of hypertensive illness* such characteristic as frequent hypertensive crisis is presence (it is a sharp increase of arterial pressure, which arises up as a result of spasm of arteriole).
- The morphological signs of crisis is goffering and destruction of basal membrane, location of endothelium as paling, plasmorrhagia, fibrinoid necrosis of walls of arteriole, thrombosis. Heart attacks and hemorrhages are developed in internal organs.

Clinic-morphological forms of hypertensive illness

Depending on predominance of structural alteration of vessels in a certain pool and related to it clinic-morphological changes, select

- kidney,
- cerebral and
- cardiac clinic-morphological forms of hypertensive illness.

A hemorrhage in a cerebrum

- In the place of hemorrhage of brain is blasted with formation of cavity, filled with convolute blood. Dug up cerebral arteries comes, as a rule, during a hypertensive crisis, in the place of microaneurism.
- Ischemic heart disease

- name the violation of its functions, conditioned absolute or relative insufficiency of coronal blood supply.
- In connection with large social meaningfulness of this pathology it is selected IHO in independent nosology unit.
- Ischemic illness shows up in
- *arrhythmias*,

- ischemic dystrophy of myocardium,*
- heart attack of myocardium,*
- cardiosclerosis.*

Ischemic heart disease

- Develops mostly for the persons of sex of men after 50 and occupies the first place in invalidisation and death rate of patients with cardio-vascular pathology.
- Ischemic illness pathogenetically is related to atherosclerosis and hypertensive illness and on the essence is their cardiac form with the general factors of risk.
- To ischemic illness can lead and other defeats of coronal arteries, in particular at rheumatism, knot periarteriitis.

Etiology and pathogenesis, risk factors.

- Direct reasons of ischemia of heart more frequent all is
- a spasm,
- thrombosis or embolism of coronal arteries, and
- also functional overload of myocardium in the conditions of sclerotic occlusion of these vessels.
- But there are only local factors of ischemia and necrosis of cardiac muscle.
- In the origin of ischemic illness as a cardiac form of atherosclerosis and hypertensive illness an important role is played by the row of favorable terms - hyperlipidemia, arterial hypertension, surplus mass of body, not mobile way of life, smoking, saccharine diabetes and gout, chronic emotional overstrain, inherited inclination. At combination for the same person during 10 of such factors, as hyperlipidemia, arterial hypertension, smoking and surplus mass, there will be ischemic illness of heart in the half of cases.

The coronary artery shown here has narrowing of the lumen due to build up of atherosclerotic plaque. Severe narrowing can lead to angina, ischemia, and infarction.

There is a severe degree of narrowing in this coronary artery. It is "complex" in that there is a large area of calcification on the lower right, which appears bluish on this H&E stain. Complex atheroma have calcification, thrombosis, or hemorrhage. Such calcification would make coronary angioplasty difficult.

Atherosclerosis of a coronary artery

Here is a coronary artery with atherosclerotic plaques. There is hemorrhage into the plaque in the middle of this photograph. This is one of the complications of atherosclerosis. Such hemorrhage could acutely narrow the lumen.

This is coronary thrombosis, one of the complications of atherosclerosis. The dark red thrombus is seen in the anterior descending coronary artery.

Here is the coronary thrombosis at higher magnification. The thrombus occludes the lumen and produces ischemia and/or infarction of the myocardium.

A coronary thrombosis is seen microscopically occluding the remaining small lumen of this coronary artery. ischemic illness of heart

There are the *sharp* and

chronic forms

A *sharp form* shows up ischemic dystrophy of myocardium of -stenocardia and

heart attack (by necrosis) of myocardium - Myocardial infarction,

chronic - cardiosclerosis.

The last is diffuse small- and largfocus or postattack largfocus.

Sometimes cardiosclerosis is complicated by chronic aneurysm of heart.

stenocardia

- Morphologically stenocardia is characterized by ischemic dystrophy of myocardium.
- It is flabby, in the focus of ischemia pale and filling out.
- Histological find out paresis of vessels, sometimes fresh blood clots, interstitial is swollen, red corpuscles stasis, disappearance of transversal banding cardiomyocytes, diapedesis hemorrhages.
- Electronic - microscopic and histochemical changes are taken to diminish the amount of granules of glycogen, swelling and destruction of chondriosome and tubules of sarcoplasmatic net.
- These changes are conditioned by violation of the tissue breathing, strengthening of anaerobic glycolysis, breaking up of breathing and oxidizing phosphorylation. In development of destructive changes of cellular organelles an important role is taken by disengaged catecholamines and to the changed water-electrolyte exchange (loss of magnesium, potassium and phosphorus but piling up of sodium, calcium and water).

Myocardial infarction

- A long duration coronal spasm, a thrombosis or occlusion of coronal vessels are reasons of transition of ischemic dystrophy of myocardium in a heart attack. A heart attack of myocardium is circulatory ischemic necrosis of cardiac muscle that is why, except for the changes of electrocardiogram, enzymemiya is a characteristic for it.
 - Morphologically it is an ischemic heart attack with hemorrhagic crownom. It is classified by the time of origin, by localization, distribution and motion.
 - Complete necrosis of cardiomyocytes is formed for a day long.
 - At first myocardium in the pool of the damaged artery is flabby, unevenly vascularity.
 - Histologically the accumulations of leucocytes appear in capillaries, emigration of them, diapedesis hemorrhages, relaxation of cardiomyocytes, disappearance in the last of glycogen and oxide restoration enzymes.
 - During next hours the outlines of fillings out cardiomyocytes become wrong, transversal banding disappears.
- This high power microscopic view of the myocardium demonstrates an infarction of about 1 to 2 days in duration. The myocardial fibers have dark red contraction bands extending across them. The myocardial cell nuclei have almost all disappeared. There is beginning acute inflammation. Clinically, such an acute myocardial infarction is marked by changes in the electrocardiogram and by a rise in the MB fraction of creatine kinase.

- The interventricular septum of the heart has been sectioned to reveal an extensive acute myocardial infarction. The dead muscle is tan-yellow with a surrounding hyperemic border.

Myocardial infarction

- In this microscopic view of a recent myocardial infarction, there is extensive hemorrhage along with myocardial fiber necrosis with contraction bands and loss of nuclei.

Macroscopically

- the area of heart attack expressly appears only through 18-24 hours after the origin of illness.
- A necrotic area acquires a grey-red color, it is limited the ribbon of hemorrhage and something comes forward above the surface of cut as a result of edema.
- The phenomena of edema disappear in subsequent days, necrotic tissue falls back, becomes dense, yellow grey. On periphery a demarcation billow which consists of leucocytes is formed, fibroblasts and macrophagocytes.
- The last take part in resorbtion of dead masses, lipids and tissue detritus accumulate in their cytoplasm. Fibroblasts take part in fibrinogenesis.
- The process of organization of heart attack lasts 7-8 weeks. Connecting tissue germinates from the area of demarcation from the round of the stored tissue in the area of necrosis. Newformed connecting tissue at first is magnificent, as granulation, afterwards passes in rough fibrose. In it and round it islands of hypertrophied cardiomyocytes appear. Investigation of this process is formation of dense scar - morphological basis of postattack largefocus cardiosclerosis.

Myocardial infarction

A necrotic area acquires a grey-red color, it is limited the ribbon of hemorrhage and something comes forward above the surface of cut as a result of edema.

This cross section reveals a large myocardial infarction involving the anterior left ventricular wall and septum.

This myocardial infarction is about 3 to 4 days old. There is an extensive acute inflammatory cell infiltrate and the myocardial fibers are so necrotic that the outlines of them are only barely visible.

This is an intermediate myocardial infarction of 1 to 2 weeks in age. Note that there are remaining normal myocardial fibers at the top. Below these fibers are many macrophages along with numerous capillaries and little collagenization

complication

The sharp heart attack of myocardium has the most frequent complication as

- cardiogenic shock,
- fibrillation of ventricles,
- asystole,
- sharp cardiac insufficiency,
- miomalation,
- sharp aneurysm and
- break of heart,
- parietal thrombosis and
- pericarditis.

complication

There is melting of myocardium in the cases of predominance of autolysis of dead tissue - *miomalation*.

Myocardium in these cases is helpless to counteract interventricle pressure of blood.

Wall of heart is thickening and knobs outside, that results in formation of additional cavity - *aneurysm* of heart. Compensately in it appears parietal blood clot. It covers the tears of endocardium and strengthens durability of wall.

At insufficient thromboformation blood penetrates under endocardium and necrotic tissue what conduces hearts to the *break*. Blood is outpoured in the cavity of cardiac shirt (*hemopericardium*).

Parietal blood clots arise up mainly at transmural and subendocardial heart attacks.

They can be the source of embolism, for example, of kidney vessels.

At subepicardial and transmural heart attacks there is reactive exudative inflammation - fibrinous pericarditis often enough

the postinfarction *break of heart*

Myocardial infarction and hemopericardium

Cardiosclerosis

makes structural basis of chronic ischemic illness of heart.

It can be atherosclerotic diffuse small focus or

can be developed at hypertensive illness,

and also postattack larg focus.

Atherosclerotic diffuse small focus or at hypertensive illness cardiosclerosis

is related to hypoxia of myocardium.

Connecting tissue replaces the places of dystrophy, atrophy and dead cardiomyocytes,

and also overgrows in perivascular spaces.

□ Macroscopically such cardiosclerosis is presented as white perivascular layers and narrow ribbons in all of layer of muscle of heart

postattack largfocus cardiosclerosis

□ Organization of heart attacks is completed by largefocus cardiosclerosis.

□ Sometimes it is the vast fields of connecting tissue, which take all layer of wall of heart.

□ In such cases it is thinned and knobs under pressure of blood - an aneurismatic sack appears.

□ There is pale white collagen within the interstitium between myocardial fibers. This represents an area of remote infarction

postattack largfocus cardiosclerosis

□ The wall of left ventricle is thickened. The muscle of heart is homogeneous. In the area of apex there is a hearth of connecting tissue with unclear contours, which occupies the considerable area of transverse section of wall of heart is postattack largefocus cardiosclerosis.

postattack largfocus cardiosclerosis

□ The tan to white areas of myocardial scarring seen from the endocardial surface here represent a remote healed myocardial infarction.

ventricular aneurysm

□ There has been a previous extensive transmural myocardial infarction involving the free wall of the left ventricle. Note that the thickness of the myocardial wall is normal superiorly, but inferiorly is only a thin fibrous wall. The thinned area represents a ventricular aneurysm that has developed as a consequence of the healed infarct. Such an aneurysm represents non-contractile tissue that reduces stroke volume and strains the remaining myocardium. The stasis of blood in the aneurysm predisposes to mural thrombosis.

Cardiac aneurysm

□ Cardiac aneurysm often occur in the left ventricle, it impairs the function of the heart and is the site for mural thrombi.

thanks