Hystomorphological and Biomechanical Study of Atherogenesis

A. Golyadkina [1], N. Chelnokova [2], I. Kirillova [1], and L. Kossovich [1]

[1] Saratov State University [2] Saratov State Medical University
nano-bio@sgu.ru

Atherogenesis is a constant, periodically exacerbating process of arterial wall tissue damage. Long before the symptom observance of atherosclerosis, in intima and lining layers of artery there starts a very complex pathogenetic mechanism of plaque formation [1]. Initially, endothelial traumatization occurs in the area of arterial wall subjected to the hemodynamics factors affection. As a result, the intima endothelial dysfunction develops and artery wall permeability increases for lipoprotein and cells elements. The organism reacts by growing dense connective tissue, which leads to alteration of biomechanical properties of vessel wall [2]. The arterial wall becomes less elastic and more dense. In turn, it leads to the formation of lipid macula (strip), fibrous atherosclerotic plaque with pronounced top made of fibrous tissue, complicated atheromatosis atherosclerotic plaque. Also, an opposite to the plaque area vessel wall starts to suffer from large hemodynamic blow along with hardening of the initial atheromatosis plaque, because the energy of the reflected wave grows with hardening of the reflecting surface. We assume that this causes the development of the fibrous atherosclerotic plaque at the opposite side of the vessel wall [3, 4].

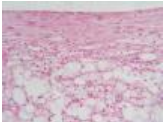
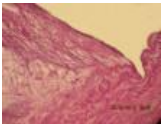
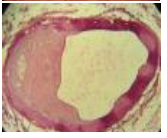
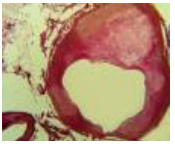
In the current work we conducted study of 60 right (180 cuts) and 60 left (180 cuts) coronary arteries at initial sections of 3 segments of right coronary artery taken from male corpses of age 31-70 years (all tissues were extracted at a condition of compliance of ethic commission recommendations). In all the considered cases, the cause of death was not connected with pathology of coronary arteries

and cardiovascular system. The material was distributed to 4 age groups: I group – 31-40 years, II group – 41-50 years, III group – 51-60 years, IV group – 61-70 years. Information that was obtained during histomorphologic study of vessel walls tissues allowed to determine the most common locations of atherosclerotic plaques (zones of bifurcations, goings of large and small branches, and places of abrupt changes of arterial vessel streamline). It was established that the largest values of the coronary artery whole wall thickness, as well as the thickness of its layers is observed in the places of atherosclerosis plaque development. In addition, it should be mentioned that they were found for all the age groups in 92.5% of cases. The initial atherosclerosis development, which is lipid spot, or atheroma, is primarily observed in the bifurcation zones, also at places of branching of coronary artery into large and small branches, and at places of sharp change of arterial branch direction. The study demonstrated that the risk group for development of atherosclerotic lesions is the initial segments of coronary arteries. With aging, between 31 to 70 years old, the atherosclerotic plaque formation within the aforementioned segments dramatically increases from 63,2 to 93,3%, also the plaques are at stage of atheromatosis and atherocalcinosis (see Table 1).

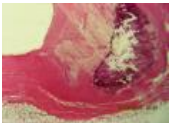
Study of biomechanical properties of coronary arteries walls allowed us to construct the characteristic curve defining alterations in rigidity of tissues at various stages of atherosclerotic lesion evolution: relatively norm (lack of pathology), lipoidosis stage (the tissues rigidity grew less by 5%), liposclerosis stage (tissue rigidity grew up by 35%), stage of complicated atherosclerotic plaque – again loss of rigidity by 10%. The latter could be explained by pulp-like disintegration (autolysis) of atheromatosis complicated atherosclerotic plaque. We studied age-depending alterations of biomechanical properties of coronary arteries walls tissues. Within the groups I to IV the artery wall rigidity increases because of the elasticity properties loss; in the proximal direction, the increase

value is up to 10,5 times, and in the distal, up to 20,0 times. Individuals of 31-40 years old have the best elasticity of the arteries walls among the age groups. The increase in the wall rigidity for individuals at the age of 41-70 years old is explained by presence of the studied pathology at the various stages of atherosclerotic lesions evolution.

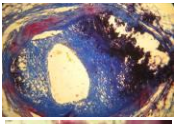
Table 1: Atherogenesis stages in coronary arteries.

Stage	Histological sections	Description
Relatively normal		Inner layer is covered by endothelium, inner elastic basal membrane is pronounced, the latter is divided by two in some areas
Lipoidosis stage – formation of lipid macula/strip		Subendothelial accumulation of large ‘foamy’ cells in vessel intima filled with intracellular lipids
Liposclerosis stage – foration of fibrous plaque		Formation of fibrous atherosclerotic plaque – growth of fibrous tissues around the zones of fats and lipoproteins infiltration
		Fibrous atherosclerotic plaque with calcium saline inclusions
		Appearance of infiltration areas opposit zone of fibrous atheromatosis atherosclerotic plaque
Stage of complicated atherosclerotic plaque: formation of atheromatosis plaque,		Developed atheromatosis plaque with lipid infiltration areas within the inner layer of opposite wall of the vessel

atherocalcinosis, alteration of fibrous top integrity, overlaying of thrombosis masses with thrombosis development



'Immersed' atheromatosis plaque with calcium saline inclusions



Ulceration of fibrous top of atheromatosal with calcinosis plaque

Recanalization of thrombus along with development of two lumens and presence of large amount of newly-formed vessels and calcium saline in plaque

The authors hope that the conducted study will allow one to develop innovative methods of early diagnostics of atherosclerosis.

References

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