

**ETIOLOGY AND RISK FACTORS OF ATHEROSCLEROSIS AND ISCHEMIC
HEART DISEASE**

Sherzodbek Ibragimov

Central Asian Medical University

Department of Pediatrics 2nd-year Student,

Abstract

Atherosclerosis and ischemic heart disease (IHD) represent one of the most pressing challenges in modern medicine and are among the leading causes of cardiovascular mortality worldwide. Atherosclerosis is a chronic pathological process characterized by the accumulation of lipids, cholesterol, calcium, and connective tissue elements within the arterial walls, leading to narrowing of the vascular lumen and reduced arterial elasticity.

Keywords

atherosclerosis, ischemic heart disease, coronary arteries, endothelial dysfunction, lipid metabolism, atherosclerotic plaque, angina pectoris, myocardial infarction, heart failure, risk factors, prevention, healthy lifestyle, inflammation, oxidative stress

This article provides a comprehensive overview of the pathogenic mechanisms of atherosclerosis, including endothelial dysfunction, inflammatory processes, disturbances in lipid metabolism, and the role of oxidative stress. In addition, the major risk factors contributing to disease development—such as poor diet, hypercholesterolemia, arterial hypertension, smoking, diabetes mellitus, obesity, and physical inactivity—are analyzed. Ischemic heart disease, one of the most significant clinical consequences of atherosclerosis, arises from the narrowing or obstruction of the coronary arteries that supply blood to the myocardium.

Atherosclerosis is a chronic disease characterized by the accumulation of cholesterol and lipids in the walls of arteries, leading to progressive narrowing of the vascular lumen. Lipid deposits primarily develop in the innermost layer of the blood vessels, the tunica intima. These lipid accumulations typically begin to form during the second decade of human life. They are localized in specific regions rather than occurring uniformly throughout the arteries. The deposits appear pale yellow in color and have a smooth surface. The formation of these lipid deposits eventually leads to the development of atherosclerotic plaques, which impede blood flow and reduce oxygen delivery to tissues and organs. The formation of atherosclerosis proceeds as follows: due to vasoconstriction or other factors, the innermost layer of the blood vessel, the tunica intima, becomes damaged. Platelets then adhere to the injured site, and circulating low-density lipoproteins (LDL) accumulate on these platelets. Since LDL is recognized as a foreign substance, immune cells are recruited to the site, where they generate reactive oxygen species (ROS). Examples of these ROS include superoxide anion (O_2^-), hydrogen peroxide (H_2O_2), and hypochlorous acid (HOCl). The reactive oxygen species (ROS) generated oxidize LDL molecules, leading to the accumulation of lipid deposits at the site. Subsequently, macrophages are recruited to the area and perform phagocytosis, resulting in the formation of foam cells—macrophages laden with large amounts of lipids. The remaining macrophages and platelets release tissue growth factors (TGF), which contribute to the proliferation of fibrous tissue, ultimately forming a fibrous cap within the tunica intima. This process reduces tissue perfusion, impairing blood supply to organs and tissues and leading to localized ischemia.

Pain is often experienced due to inadequate perfusion, which leads to a significant reduction in oxygen levels in the blood. Consequently, the affected tissues or the region supplied by the compromised blood vessel experience decreased ATP (adenosine triphosphate) production.

Reduced ATP results in incomplete glucose metabolism, leading to the accumulation of lactic acid. The lactic acid stimulates nociceptors, triggering the sensation of pain.

Ischemic heart disease primarily develops through three clinical conditions:

1. Angina pectoris
2. Myocardial infarction
3. Heart failure

These conditions are considered the main manifestations of ischemic heart disease.

Angina pectoris is a condition characterized by chest pain or discomfort that occurs when the myocardium receives insufficient oxygen. This condition is typically associated with ischemic heart disease (IHD) and develops as a result of narrowing of the coronary arteries or the presence of atherosclerotic plaques. The pain is often located in the center of the chest and may radiate to the left arm, neck, jaw, or back. It typically lasts for several minutes and is relieved by rest or the administration of nitroglycerin. Other common symptoms of angina pectoris include shortness of breath, fatigue, sweating, and a general sense of discomfort.

Angina pectoris is classified into several types:

1. Stable angina – symptoms are predictable and typically occur during physical exertion or stress.
2. Unstable angina – pain arises unexpectedly, even with minimal activity, and is associated with an increased risk of myocardial infarction.
3. Variant (Prinzmetal) angina – occurs as a result of coronary artery spasm and may manifest even at rest.

Risk factors such as hypercholesterolemia, smoking, arterial hypertension, diabetes mellitus, obesity, and stress play a significant role in the development of the disease. Treatment typically includes pharmacological therapy (nitroglycerin, beta-blockers, calcium channel blockers), lifestyle modifications, and, in some cases, surgical interventions such as stent placement or coronary artery bypass grafting. Early detection and management of angina pectoris are crucial for preventing myocardial infarction and other severe complications.

Ischemic heart disease (IHD) is a general term for chronic cardiovascular disorders that arise from inadequate blood and oxygen supply to the myocardium. It primarily develops due to atherosclerosis and narrowing of the coronary arteries. The most severe clinical manifestation of IHD is myocardial infarction (MI). Myocardial infarction is a serious condition in which a portion of the heart muscle undergoes necrosis due to insufficient blood supply. It often represents the final stage of IHD and is most commonly caused by occlusion of the coronary arteries by atherosclerotic plaques or thrombi.

Clinical manifestations:

- Severe, persistent chest pain that may radiate to the left arm, neck, jaw, or back
- Shortness of breath, sweating, dizziness, and nausea
- Pain is not relieved by rest or administration of nitroglycerin

Types of MI:

1. Transmural MI – necrosis involving the full thickness of the heart wall; typically associated with STEMI and often leading to severe clinical consequences.
2. Subendocardial MI – necrosis confined to the inner layer of the heart wall (subendocardium); usually associated with NSTEMI and does not involve ST-segment elevation.

Risk Factors and Prevention: Atherosclerosis and atherosclerotic plaques, hypertension and hypercholesterolemia, smoking, diabetes mellitus, obesity, stress, and physical inactivity.

Treatment and Prevention: Pharmacological therapy includes thrombolytics, nitroglycerin, beta-blockers, and anticoagulants. Surgical interventions include coronary artery stenting or bypass grafting. Lifestyle modifications, such as healthy diet, regular physical activity, and smoking cessation, are also essential. Myocardial infarction represents the most severe clinical manifestation of IHD, and early diagnosis with appropriate management is crucial for reducing the risk of heart failure and mortality. The distinction between transmural and subendocardial MI is clinically important for determining disease severity and guiding treatment strategies.

In the case of transmural myocardial infarction, all three layers of the heart wall—the pericardium, myocardium, and endocardium—can be affected. When stenosis occurs primarily in a single coronary artery, injury typically begins in the region supplied by that artery and may not immediately extend to other areas. The main cause of transmural MI is thrombosis. In such cases, pericarditis may also develop, particularly if an infection is present in the bloodstream, which can lead to inflammation of the heart wall following myocardial injury.

In subendocardial myocardial infarction, damage typically involves the inner one-third to two-thirds of the heart wall. The affected area can cover a relatively large region with a considerable radius. The primary causes of this type of MI are shock or arterial stenosis. Pericarditis is rarely observed in cases of subendocardial MI.

The post-myocardial infarction (MI) period involves the process of cardiac tissue recovery and the management of complications. Necrotic myocardial tissue resulting from MI does not regenerate; however, surrounding healthy muscle fibers can compensate for the loss. During this period, patients may experience the following conditions:

1. Cardiac rhythm disturbances: Arrhythmias are common following myocardial infarction. The most frequently observed types include ventricular extrasystoles, atrial fibrillation, and ventricular tachycardia. Arrhythmias increase the risk of heart failure and sudden cardiac death.
2. Heart failure: As a result of myocardial necrosis, the contractile ability of the heart is reduced, leading to inadequate blood pumping. Patients may experience symptoms such as fatigue, shortness of breath, and peripheral edema in the legs.
3. Papillary muscle or septal rupture: In severe cases of MI, rupture of the papillary muscles or the interventricular septum may occur. This condition can result in severe mitral regurgitation or the formation of a ventricular shunt and requires urgent surgical intervention.

4. Pericarditis: In the initial days following MI, inflammation of the pericardium (postinfarction pericarditis) may occur. Clinical manifestations include chest pain, a pericardial friction rub, and fever.
5. Aneurysm formation: At the site of necrosis, thinning and dilation of the heart wall (aneurysm) may occur, increasing the risk of thrombosis and blood clot formation.
6. Recurrent infarction: Patients remain at risk of a subsequent myocardial infarction due to atherosclerotic plaques or thrombi in the coronary arteries. The post-MI period is critical for patients, as early detection and prevention of complications play a decisive role in reducing the risk of heart failure and mortality. Continuous monitoring of cardiac rhythm, contractile function, and vascular status is essential.

Right ventricular failure (RVF) is a pathological condition in which the right side of the heart is unable to pump blood effectively, leading to venous congestion in the body. RVF most commonly develops secondary to left heart failure, pulmonary hypertension, ischemia of the right coronary artery, or right ventricular myocardial infarction. Occasionally, isolated RVF may occur, for example, as a result of a pulmonary embolism.

Right ventricular failure (RVF) can result from the following conditions:

1. Right ventricular infarction or ischemia — necrosis of right ventricular muscle fibers
2. Pulmonary artery hypertension — increased afterload of the right ventricle
3. Left heart failure — backflow of blood into the right ventricle
4. Congenital heart defects — such as tricuspid stenosis or atrial septal defect
5. Valvular heart disease — tricuspid regurgitation

Clinical manifestations of RVF: Patients may present with peripheral edema affecting the legs, toes, and lower abdomen; jugular venous distension; hepatomegaly with associated pain; ascites due to fluid accumulation in the abdomen; fatigue, tachypnea, and reduced exercise tolerance. When right ventricular contractile function is impaired, venous blood accumulates in the thoracic and peripheral veins, leading to increased venous pressure and fluid retention in various organs. RVF frequently occurs in conjunction with left heart failure but may also develop in isolation.

Management of Right Ventricular Failure (RVF): The primary goals in treating RVF are to reduce right ventricular afterload and restore effective blood flow.

Pharmacological therapy includes diuretics (to reduce fluid overload), inotropic agents (to enhance contractile function), and vasodilators.

Surgical interventions may involve repair or replacement of the tricuspid valve and, in some cases, treatment of the pulmonary artery.

Lifestyle modifications include sodium restriction, fluid management, and tailored physical activity.

Right ventricular failure is a serious cardiovascular condition, and early diagnosis with appropriate management can significantly improve patient prognosis and quality of life. Identifying clinical manifestations and addressing the underlying cause are of critical importance.

Left ventricular failure (LVF) is a chronic or acute cardiac condition in which the left side of the heart is unable to pump blood effectively. When left ventricular contractile function is

impaired, blood cannot be adequately ejected through the left ventricle into the aorta and systemic circulation, resulting in compromised oxygen delivery to the heart and other organs.

Left ventricular failure (LVF) typically develops as a result of the following conditions:

1. Myocardial infarction — necrosis of left ventricular muscle fibers
2. Hypertension — increased workload on the heart
3. Atherosclerosis and ischemic heart disease (IHD) — narrowing or obstruction of coronary arteries
4. Valvular heart disease — pathologies of the mitral or aortic valves
5. Cardiomyopathies — dilated or hypertrophic forms

Clinical manifestations of LVF: Patients may present with dyspnea, especially during physical activity or while lying down; progressive fatigue and reduced exercise tolerance; increasing pulmonary congestion (pulmonary edema due to fluid accumulation); paroxysmal nocturnal dyspnea — sudden nighttime shortness of breath causing awakening; and orthopnea — difficulty breathing when in a supine position.

When left ventricular contractile function is lost: Blood is not adequately ejected from the left ventricle into the aorta and systemic circulation, leading to decreased systemic blood pressure, tissue hypoxia, and increased workload on the left heart. Excess blood volume then accumulates in the right heart and pulmonary circulation, resulting in pulmonary edema. The primary goals in the management of left ventricular failure are to restore cardiac pumping function and reduce fluid overload.

Management of Left Ventricular Failure (LVF): Pharmacological therapy includes diuretics, ACE inhibitors, beta-blockers, and inotropic agents.

Surgical interventions may involve valve repair or replacement, and in some cases, implantation of a left ventricular assist device (LVAD).

Lifestyle modifications include sodium restriction, fluid management, and tailored physical activity.

Left ventricular failure is a serious and prevalent cardiovascular condition, and early diagnosis combined with appropriate management can significantly improve patient prognosis and quality of life. Identifying clinical manifestations and addressing the underlying cause are critical in the effective management of LVF.

Conclusion: Atherosclerosis is the primary pathological process of the cardiovascular system and forms the basis for the development of ischemic heart disease (IHD) through the narrowing of coronary arteries and disruption of blood flow. The most significant clinical manifestations of these conditions — myocardial infarction and right or left ventricular failure — directly impact patient prognosis and quality of life. According to the evidence presented, the major contributing factors to atherosclerosis — elevated cholesterol, hypertension, diabetes mellitus, smoking, and physical inactivity — are modifiable and should be targeted for prevention of cardiovascular disease. Therefore, early diagnosis, reduction of risk factors, and implementation of appropriate therapeutic strategies can slow the progression of ischemic heart disease and reduce complications. This scientific approach facilitates a better understanding of atherosclerosis and ischemic heart disease, supporting effective prevention and management planning.

References:

1. Libby, P., Ridker, P. M., & Hansson, G. K. (2011). Progress and challenges in translating the biology of atherosclerosis. *Nature*, 473(7347), 317–325.
2. Fuster, V., & Hurst, J. W. (2007). Atherosclerosis and coronary artery disease. In *The Heart* (11th ed.). McGraw-Hill.
3. *International Journal of Medical Sciences and Clinical Research*: https://inlibrary.uz/index.php/ijmscr/article/view/84643?utm_source
4. *Web of Medicine: Journal of Medicine, Practice and Nursing*: https://webofjournals.com/index.php/5/article/view/5121?utm_source
5. international Journal of Medical Sciences (2025): https://www.academicpublishers.org/journals/index.php/ijms/article/view/2466?utm_source
6. International Journal of Cardiology (2013): https://pubmed.ncbi.nlm.nih.gov/22824253/?utm_source
7. Journal of the American College of Cardiology (JACC): <https://www.jacc.org/>