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Atherosclerosis: A brief review on treatment of atherosclerosis

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A B S T R A C T

Atherosclerosis is characterized by the progressive narrowing and hardening of arteries resulting from the accumulation of plaque. Plaque comprises lipids, cholesterol, calcium, and various other blood-borne substances. This gradual buildup can impair or obstruct blood flow, increasing the risk of adverse cardiovascular events such as myocardial infarction, stroke, and related diseases. Often asymptomatic for extended periods, atherosclerosis poses significant health risks due to its insidious nature. Principal risk factors include poor dietary habits, physical inactivity, tobacco use, hypertension, diabetes, and elevated cholesterol levels. Early detection combined with lifestyle modifications including balanced nutrition and consistent exercise is critical for effective management and prevention of atherosclerosis.

Keywords: Atherosclerosis, cholesterol, poor dietary habits, physical inactivity, tobacco use, hypertension

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Contents

1. Introduction. 68
2. Causes atherosclerosis. 69
3. Pharmacological classification. 70
4. Conclusion 70
5. References.. 71

1. Introduction

Atherosclerosis is a condition where the arteries become narrowed and hardened due to a buildup of fatty deposits called plaques on the inner walls of the blood vessels. These plaques are made up of cholesterol, fats, calcium, and other substances found in the blood. Over time, they can restrict blood flow or even block it completely. This disease can affect arteries anywhere in the body, including those supplying the heart (leading to heart attacks), brain (causing strokes), and limbs (causing peripheral artery disease). Atherosclerosis develops slowly and often doesn't show symptoms until serious problems occur. Atherosclerosis is a chronic disease where the arteries become narrowed or hardened due to the build-up of plaque along their inner walls. Arteries are the blood vessels that carry oxygen-rich blood from the heart to the rest of the body. When plaque builds up, it reduces or blocks the flow of blood, which can lead to serious problems like heart attacks, strokes, or organ damage. Plaque is made up of fat, cholesterol, calcium, and other substances found in the blood. In the early stages, atherosclerosis may not cause any symptoms. However, over time, the affected artery becomes so narrow that it can restrict blood flow, or a piece of the plaque can rupture, leading to a blood clot.

This clot can block the artery completely, causing life-threatening conditions like a myocardial infarction (heart attack) or ischemic stroke. Atherosclerosis develops silently and slowly over decades, which is why it is often called a "silent killer." It usually becomes clinically evident in older adults. Despite improvements in diagnosis and treatment, CAD remains the leading cause of death globally. Atherosclerotic plaques form when lipids accumulate in the

artery walls beneath a single layer of endothelial cells. These plaques include inflammatory cells, smooth muscle cells, and dead cell debris. Plaque is made up of fat, cholesterol, calcium, and other substances found in the blood. In the early stages, atherosclerosis may not cause any symptoms. However, over time, the affected artery becomes so narrow that it can restrict blood flow, or a piece of the plaque can rupture, leading to a blood clot. This clot can block the artery completely, causing life-threatening conditions like a myocardial infarction (heart attack) or ischemic stroke.

Atherosclerosis Develops:

The process begins with damage to the inner layer (endothelium) of the artery. This can be caused by:

- High blood pressure
- Smoking
- Diabetes
- High LDL ("bad") cholesterol
- Obesity or a sedentary lifestyle

After the injury, the body tries to repair the area. However, during this repair, fats and cholesterol accumulate and form fatty streaks. Over time, these turn into fibrous plaques that can calcify and stiffen the arteries.

2. Causes atherosclerosis

Pathogenesis of Atherosclerosis with Detailed Explanation of Endothelial Dysfunction:

Atherosclerosis is a chronic inflammatory disease of the arterial wall characterized by the accumulation of lipids, immune cells, and fibrous elements, forming plaques that narrow or block arteries. The pathogenesis begins with endothelial dysfunction, a key initiating event.

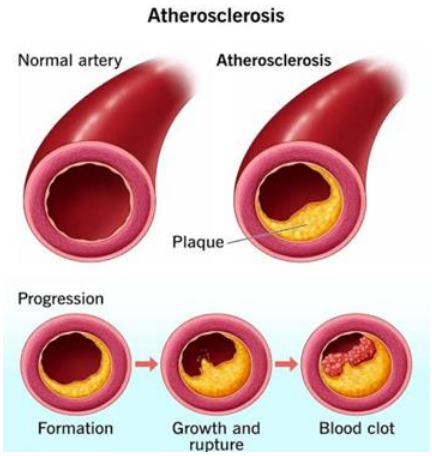

Fig.1

Endothelial Dysfunction – The Triggering Event

The endothelium is the inner lining of blood vessels. Under healthy conditions, it:

- Maintains vascular tone
- Prevents adhesion of inflammatory cells
- Inhibits thrombosis (blood clotting)
- Regulates smooth muscle cell growth

When Endothelial Dysfunction Occurs:

The endothelium loses its protective function due to various risk factors:

- Hypertension
- Hyperlipidemia (especially high LDL)
- Smoking
- Diabetes Mellitus
- Obesity
- Oxidative stress
- Turbulent

Table.1

Endothelial Dysfunction		
Function	**Normal Endothelium**	**Dysfunctional Endothelium**
Vasodilation	Produces nitric oxide (NO) to relax vessels	↓ NO → Vasoconstriction
Anti-inflammatory	Resists adhesion of leukocytes	↑ Expression of adhesion molecules (VCAM-1,ICAM-1)
Anti-thrombotic	Produces prostacyclin, NO heparan	Promotes clot formation
Barrier function	Tight junctions, selective permeability	↑ Permeability to LDL and monocytes

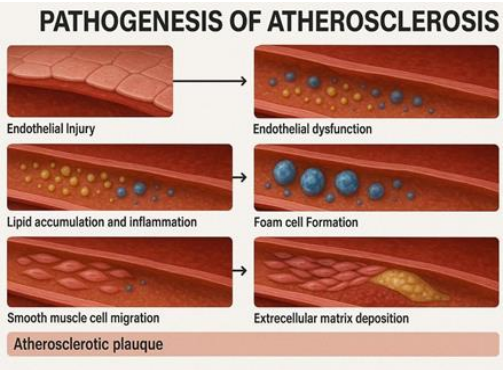

Fig.2

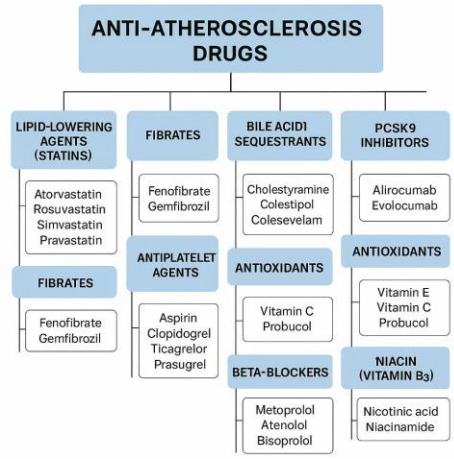

Fig.3

Endothelial Injury: Artery lining is damaged by factors like hypertension, smoking, diabetes, or high cholesterol.

Endothelial Dysfunction: Vascular functions decline; inflammatory cell adhesion starts.

Lipid Accumulation and Inflammation: LDL builds up, oxidizes, and causes inflammation.

Foam Cell Formation: Macrophages ingest oxidized LDL, forming foam cells and fatty streaks.

Smooth Muscle Migration & Matrix Deposition:

Muscle cells move to the intima, release collagen, and thicken vessel walls.

Atherosclerotic Plaque: Hardened plaque narrows arteries, limiting blood flow.

3. Pharmacological classification

Statins and Their Role in Treating Atherosclerosis

- Statins are a class of lipid-lowering drugs that inhibit the enzyme HMG-CoA reductase.
- This enzyme is responsible for the synthesis of cholesterol in the liver.
- By blocking it, statins reduce LDL (bad cholesterol) levels in the blood, the main cause of atherosclerotic plaque buildup.

Mechanism of action:

Inhibition of HMG-CoA Reductase:

- Decreases cholesterol synthesis in the liver.
- Upregulation of LDL Receptors:
- Liver cells produce more LDL receptors to pull more LDL out of the bloodstream.
- Reduction in Plasma LDL Levels:
- Leads to less cholesterol deposition in arterial walls.
- Anti-inflammatory and Antioxidant Effects:
- Reduce vascular inflammation, oxidative stress.

These combined actions make statins highly effective in lowering overall cardiovascular risk. By targeting both cholesterol synthesis and inflammation, statins provide a multifaceted defense against the progression of atherosclerosis.

Therapeutic uses of statins:

Therapeutic Uses of Statins in Atherosclerosis

Lowers LDL Cholesterol: Statins reduce the production of bad cholesterol (LDL) in the liver, which helps prevent cholesterol buildup in blood vessels.

Prevents Plaque Formation: By lowering LDL levels, statins slow down the development of fatty plaques inside arteries.

Stabilizes Existing Plaques

Statins strengthen the plaque surface, making it less likely to rupture and cause heart attacks or strokes.

Improves Blood Vessel Function

Statins help blood vessels relax and improve blood flow, reducing strain on the heart.

Reduces Inflammation

They decrease inflammation in the artery walls, protecting them from further damage and slowing disease progression.

Fibrates and Their Role in Treating Atherosclerosis

- Fibrates are a class of lipid-lowering drugs that mainly reduce triglycerides and increase HDL (good cholesterol).
- They work by activating PPAR-α (Peroxisome Proliferator-Activated Receptor Alpha): a protein that helps regulate fat metabolism in the liver and blood.

Fibrates are especially useful for patients whose primary lipid abnormality is high triglycerides, rather than elevated LDL cholesterol. They are often prescribed in combination with other cholesterol-lowering medications for a more comprehensive approach to cardiovascular risk reduction. Regular monitoring is recommended to ensure effectiveness and minimize potential side effects.

Mechanism of Action

- Activation of PPAR-α increases the breakdown of fatty acids and triglycerides.
- This lowers VLDL (very low-density lipoproteins) and triglyceride levels.
- At the same time, fibrates raise HDL cholesterol, helping clear cholesterol from the arteries.

Therapeutic Uses of Fibrates in Atherosclerosis:

Lowers Triglycerides

Fibrates reduce high triglyceride levels that contribute to atherosclerotic plaque formation.

Increases HDL Cholesterol

They boost "good" cholesterol, which helps remove cholesterol from artery walls.

Reduces LDL and VLDL Levels

By decreasing bad fats in the blood, fibrates help prevent further plaque buildup.

Improves Endothelial Function

Fibrates enhance the health of blood vessel walls, improving blood flow and reducing damage.

Prevents Cardiovascular Events

Regular use lowers the risk of heart attacks, stroke, and peripheral artery disease in patients with atherosclerosis.

Antioxidants:

- Antioxidants are natural or synthetic substances that prevent or reduce oxidative damage caused by free radicals in the body.
- In atherosclerosis, oxidative stress leads to oxidation of LDL cholesterol, which plays a major role in plaque formation.
- By neutralizing free radicals, antioxidants help protect blood vessels and slow the progression of atherosclerosis.

Therapeutic Uses of Antioxidants in Atherosclerosis:

Prevents LDL Oxidation

Antioxidants stop the oxidation of LDL cholesterol, a key step in plaque formation inside arteries.

Reduces Inflammation

They are lower inflammatory responses in the vessel wall, reducing further damage and narrowing.

Protects Endothelial Cells

Antioxidants keep the inner lining of blood vessels healthy, improving vascular function.

Slows Plaque Progression

By minimizing oxidative stress, antioxidants slow down the growth of atherosclerotic plaques.

Improves Heart Health

Regular intake supports overall cardiovascular health and reduces the risk of heart attack and stroke.

4. Conclusion

Atherosclerosis is a long-term disease that causes the arteries to become narrow and hard due to the buildup of fatty plaques. This condition reduces blood flow and increases the risk of serious problems such as heart attack

and stroke. Maintaining a healthy lifestyle through a balanced diet, regular physical activity, and avoiding smoking plays an important role in preventing the disease. Medications like statins, fibrates, and antioxidants help to lower cholesterol levels, reduce inflammation, and protect the blood vessels from further damage.

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