

UNIT 5

HEART DISORDERS |

Structure

5.1	Introduction	Role of Lipids in Atherosclerosis
	Expected Learning Outcomes	
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	Types of Heart Diseases	
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5.1 INTRODUCTION

In previous unit 4 you have learned about the metabolic lifestyle disorders such as obesity, diabetes mellitus, hypertension and hypothyroidism and their dietary management. This unit deals with the heart disorders. Heart disorders or cardiovascular diseases are one of the lifestyle disorders. The term "**heart disorders**" covers a wide spectrum of cardiac ailments. Heart illness affects the structure and function of heart and blood vessels. Most people think that heart disease is a single condition. Heart disease is a term used to describe a group of diseases related to both heart and blood vessels. Cardiovascular diseases (CVDs) are the abnormalities of heart or blood vessel. CVDs are now a common lifestyle disorder worldwide and caused by obesity, diabetes, and unhealthy diet, hereditary and environmental factors. Recall the unit 3 and 4 for better understanding about structure and function of heart and blood vessels respectively from IV semester course, Human Physiology-BBCCT-115 (BSCBCH).

Therefore, this unit will give an overview of CVDs and in particular pathogenesis, risk factors and complications of atherosclerosis in details.

Expected Learning Outcomes

After studying this unit, you should be able to:

- ❖ define the different types of cardiovascular diseases;
- ❖ differentiate between the terms cardiovascular diseases (CVDs) and coronary heart disease (CHD);
- ❖ describe pathogenesis and biochemistry of atherosclerosis;
- ❖ explain the steps of development of atherosclerosis;
- ❖ explain the role of fats (LDL) in atherosclerosis;
- ❖ identify and list a number of risk factors that contribute to the development of cardiovascular diseases; and
- ❖ know the prevention and diagnosis of CVDs.

5.2 CARDIOVASCULAR DISORDERS

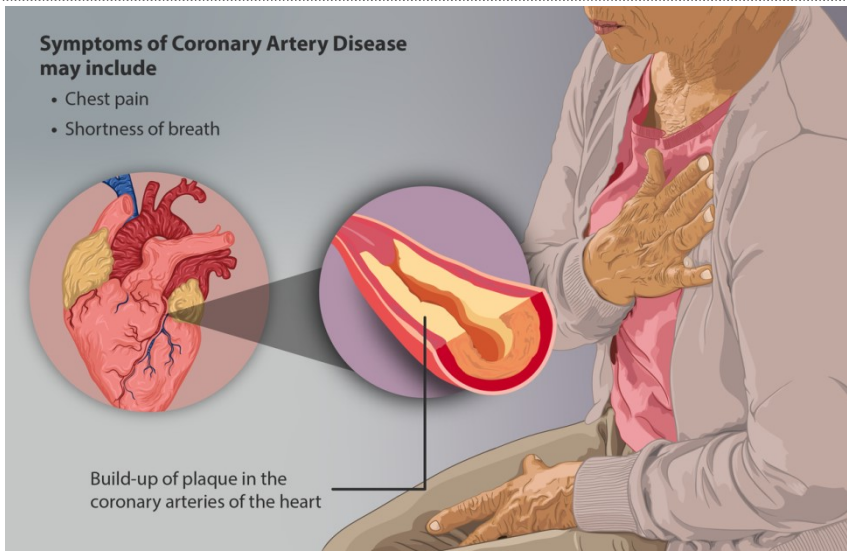
"**Cardiovascular disorders**" (CVDs) refer to a wide range of heart and circulatory system diseases. CVDs are diseases that affect the heart, brain, and blood vessels. CVDs continue to be the leading cause of death in the modern world. According to the World Health Organization (WHO), approximately 17.9 million people died from CVDs in 2019, accounting for 32% of all global deaths. A heart attack or stroke was responsible for approximately 85 % of these deaths. CVDs account for nearly a quarter (24.8 percent) of all deaths in India, according to the Global Burden of Disease.

Some changes in the heart and blood vessels are associated with ageing, poor diet, and, if not treated, can lead to heart disease. Despite the fact that heart attacks and strokes are major killers around the world, controlling the main risk factors of tobacco use, poor diet, and physical inactivity could prevent up to 80% of these deaths.

5.2.1 Types of CVDs

The major CVDs are as follows:

1. **Coronary heart disease** (CHD) is the coronary artery disease which is major CVD in worldwide. It is also called ischemic heart disease. Ischemic means insufficient blood or oxygen supply by the heart. CHD occurs when the coronary arteries become too narrow or blockage usually caused by the buildup of fatty material called plaque. The coronary arteries are the main blood vessel that supply oxygenated blood to the heart.



Please open video link to view animation of heart attack
https://en.wikipedia.org/wiki/File:Heart_attack_animation.ogv

Fig. 5.1: Coronary artery disease Image credit: https://en.wikipedia.org/wiki/Coronary_artery_disease

- Atherosclerosis** disease refers to the hardening of the arteries (coronary artery and vascular arteries). The pathogenesis of atherosclerosis is discussed in detail in next section 5.3. It is the most common type of heart disease and is responsible for CHD, heart attacks and angina (chest pain). Atherosclerosis typically does not cause symptoms until the vessel's luminal diameter has shrunk by 70 to 80 %. It causes blockage of the coronary arterial wall due to accumulation of plaque (fatty material) which often reduces blood flow and impairs the heart function. In this condition, the blocked arteries are unable to carry normal blood flow which result in poor oxygenation and chest pain and further leads to heart attack.
- Arrhythmias (heart rhythm disorders)** cause the heart to beat too slowly, too quickly, or in an unorganised manner. Millions of Canadians suffer from heart rhythm disorders, which cause blood flow to be disrupted.
- Structural heart disease:** Abnormalities of the heart's structure, such as its valves, walls, muscles, or blood vessels near the heart, are referred to as structural heart disease. It can be congenital (present at birth) or acquired later in life due to infection, wear and tear, or other factors. People with heart defects and their families require assistance at all ages and stages of life, as they frequently require ongoing medical care and surgical procedures.
- Congestive heart failure:** Heart failure is a life-threatening condition that occurs when the heart is damaged or weak. Heart attacks and high blood pressure are the two most common causes of heart failure.
- Hypertension:** Hypertension refers to High blood pressure (BP). It occurs when blood pressure remains consistently higher than normal range of BP that is 120/80 mmHg. Hypertension raises the risk of heart disease, stroke, brain and kidney disorders, and other health problems (Fig. 5.2). According to the World Health Organization, it is a major cause of premature death worldwide, affecting over a billion people, including at least one in every four men and one in every five women.

Normal blood pressure is less than 120/80. This means that a systolic pressure less than 120 and a diastolic pressure less than 80.

A systolic blood pressure of 120 to 129 and a diastolic blood pressure of less than 80 indicates elevated blood pressure.

A systolic blood pressure of 130 to 139 or a diastolic blood pressure of 80 to 89 is considered stage 1 high blood pressure.

A systolic blood pressure of 140 or higher, or a diastolic blood pressure of 90 or higher, is considered stage 2 high blood pressure.

Main complications of persistent
High blood pressure

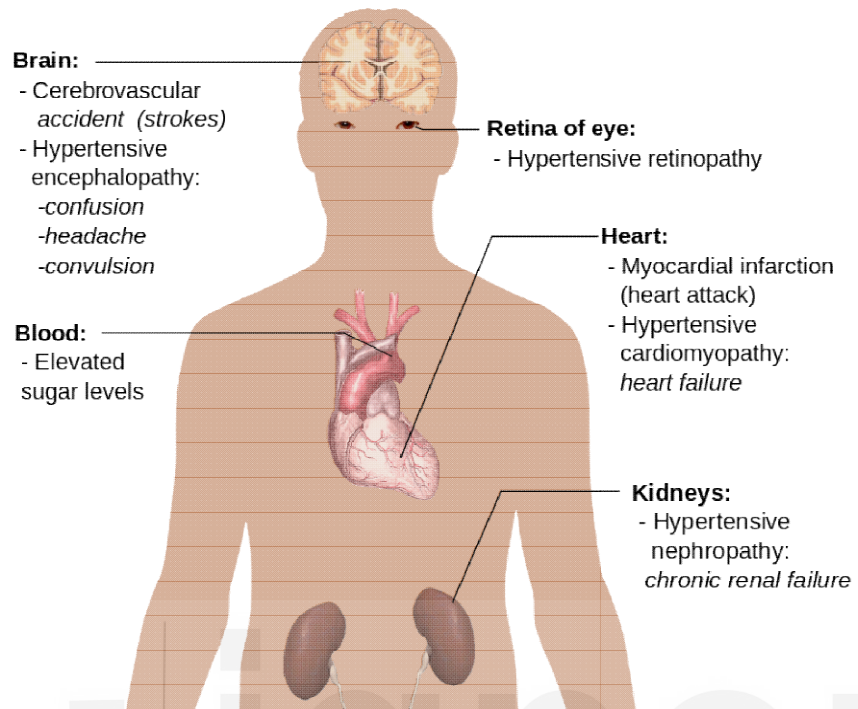


Fig.5.2: Major Health complications of hypertension.

Image source: Public domain

6. **Heart failure (HF):** It is state of the heart when it is not pumping blood efficiently to maintain blood flow as per the body's requirement. It is also called as congestive heart failure (CHF) or congestive cardiac failure (CCF). It can be caused by certain heart conditions, such as narrowed arteries in the heart (coronary artery disease) or high blood pressure. It makes the heart too weak or stiff, which is unable fill and pump blood properly. The common signs and symptoms of heart failure include shortness of breath, excessive tiredness, irregular heartbeat (Arrhythmias), swelling in the legs, oedema, nausea etc. Heart failure can be life-threatening. Adequate and timely treatment can improve the condition and may help some people live longer. Lifestyle changes; such as losing weight, exercising, less salt (sodium) intake and managing stress are suggested preventive measures. People with heart failure may need a heart transplant or a ventricular assist device (VAD).

SAQ 1

Define the followings:

- i) Arrhythmias
 - ii) Congestive heart failure
 - iii) Hypertension
-

5.3 ATHEROSCLEROSIS

The term "atherosclerosis" is derived from the Greek word "athero," which means "gruel." In 1904, the scientist Felix March used the term "atherosclerosis" to refer to the occurrence of fatty degeneration and arterial hardening in conjunction. In 1908, A.I. Ignatowski established the first association between cholesterol-rich diets and experimental atherosclerosis. Atherosclerosis is a patchy intramural subintimal thickening. Normally, the walls of arteries are smooth, allowing blood to flow freely. When harmful materials deposit on the arterial wall, atherosclerosis occurs. This material is composed of oxidised fat, cholesterol, and various other components. Eventually, the debris collects and forms a plaque, causing the artery to constrict (Fig. 5.3). When the accumulation is significant, the vessel may become entirely blocked by a clot. Therefore, atherosclerosis is a disease that is defined by the hardening of the medium or large blood vessels as a result of the deposition of atheromatous plaque on their walls. Plaque may harden over time, resulting in arterial narrowing. The hard plaque obstructs the natural flow of oxygen-rich blood to the body's organs, which can result in coronary artery disease, heart attack, renal problems, tissue death, or infection in the arms, legs, or other body parts. Occasionally, a fragment of plaque breaks, travels through the bloodstream, and becomes lodged someplace in the body, causing injury.

The lower abdominal aorta and the coronary arteries are the two major sites most typically thickened by atherosclerosis. Within the coronary arteries, the branch points, which resemble forks in the road, gather the most atherosclerotic plaque.

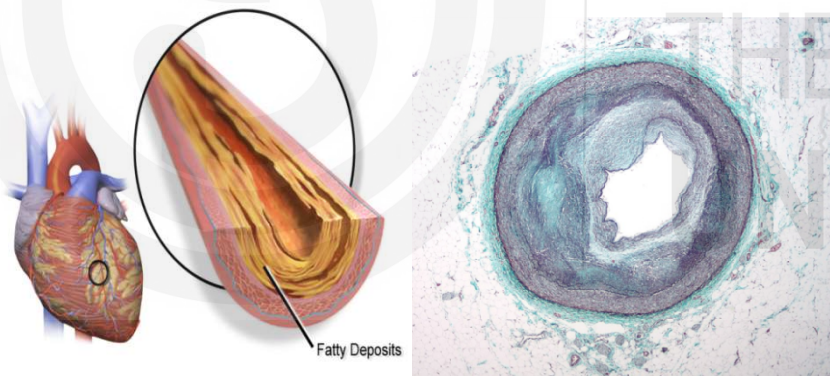


Fig. 5.3: a) Coronary Artery Disease. b) of a [coronary artery](#) with complex atherosclerosis showing luminal narrowing. Source: Wikimedia.comons https://www.textbookofcardiology.org/wiki/File:Atherosclerosis_damage.svg

5.3.1 Classification

Arteriosclerosis, also known as arterial stiffness can be divided into three types.

- i) Atherosclerosis
- ii) Arteriolosclerosis
- iii) Monckeberg medial calcific sclerosis

(i) Atherosclerosis

Atherosclerosis (also referred to as arteriosclerotic vascular disease or ASVD) is a type of arteriosclerosis. It is the mature stage of arteriosclerosis. The intima of the arterial wall begins to enlarge with the deposition of various amounts and types of lipids, inflammatory cells, connective tissues, matrix proteins, enzymes, and calcium deposits, resulting in arteriosclerosis plaque. Atherosclerosis is the term used to describe the advanced stage of lipid plaque within blood vessels. It is a combination of atheroma and arteriosclerosis. When the inner wall of an artery is damaged, blood cells and other substances frequently clump at the injury site and accumulate in the artery's inner lining. Over time, fatty deposits (plaque) composed of cholesterol and other cellular products form at the site of the injury and harden, narrowing the arteries. The organs and tissues connected to the blocked arteries are then deprived of sufficient oxygenated blood to function properly. A myocardial infarction can occur if blood flow to the heart is interrupted (heart attack). A stroke can occur if the blood supply to the brain is cut off.

(ii) Arteriolosclerosis affects small arteries and arterioles (very small arteries). It involves thickening of the vessel walls that narrows the lumen. Similar to atherosclerosis in the larger vessels, the process of arteriolosclerosis can lead to ischemia, or insufficient blood flow to organs supplied by the blocked vessels. Arteriolosclerosis is most often seen in people who have diabetes mellitus, high cholesterol level (hypercholesterolemia) or high blood pressure, though it is also a normal part of aging.

(iii) Monckeberg medial calcific sclerosis is the third type of arteriosclerosis and is defined by calcium deposits in the muscular arteries of people over the age of 50.

SAQ 2**Do as directed**

- i) Who coined the name Atherosclerosis?
 - ii) Differentiate between arteriolosclerosis and Monckeberg medial calcific sclerosis.
 - iii) Arterial stiffness is also known as.....
 - iv) Diabetes and hypercholesterolemia can lead to develop.....
-

5.4 PATHOGENESIS OF ATHEROSCLEROSIS

Atherosclerosis is a chronic inflammatory and degenerative disease that affects both men and women. It is characterised by the thickening or

hardening of blood arteries caused by lipid buildup and immunological activation in the arterial wall. The buildup of debris in the walls of blood vessels (arteries) results in the narrowing of the vessels' lumens. As a result, regular blood flow and blood supply decreasing with increasing blood pressure which ultimately affects the body's functions.

The process of atherosclerosis involves foam cells, fatty streaks, plaque formation, and plaque destabilizer.

(i) Formation of Foam cells

Foam cells, also known as lipid-laden macrophages, are a type of cholesterol-containing cell. These can combine to form a plaque, which can lead to development of atherosclerosis. Atherosclerotic plaque is characterised by the accumulation of fat-filled macrophages, also known as foam cells.

Low density lipoproteins (LDL) are abundant in foam cells, giving them a foamy appearance. Hence, they're known as foam cells.

A number of factors contribute to foam cell formation, including the uncontrolled uptake of oxidized low-density lipoproteins (LDL), the upregulation of cholesterol esterification, and the impairment of cholesterol metabolism. Foam cells form when circulating monocyte-derived cells are recruited to the site of an atherosclerotic lesion or fat deposits in the blood vessel walls. Leukocytes (white blood cells) are drawn to areas of cell injury in arterial walls, and the incoming leukocytes trigger a local inflammatory response. Macrophages are among the attracted leukocytes. Macrophages are lipid-eating cells that start by engulfing the local lipids. When macrophages are overburdened by lipids in their environment, they bloat up with fatty debris.

(ii) Fatty Streaks

The fatty streak is the first lesion to appear in atherosclerosis. Diets high in fat cause fatty streaks to form along the walls of large arteries. The fatty streak, which is an accumulation of lipid-laden foam cells in the intimal layer of the artery, is the first sign of atherosclerosis. The first step in the pathogenesis of atherosclerosis is lipid retention, which is followed by chronic inflammation at vulnerable sites in the walls of major arteries, resulting in fatty streaks, which then progress to fibrous fibroatheromas. The formation of fatty streaks is promoted by endothelial injury that allows low-density lipoprotein and other large molecules to penetrate the subendothelium. Fatty streaks evolve to atherosclerotic plaques which is composed of three components namely of inflammatory cells, smooth muscle cells, a fibrous component of connective tissue and a fat component of lipids.

Therefore, endothelial injury causes inflammation within the vessel wall, paving the way for an atherosclerotic lesion to form and progress. This is mediated by a number of risk factors, and it leads to an increased susceptibility of the vasculature to atheroma formation.

Cross-section of atherosclerotic artery

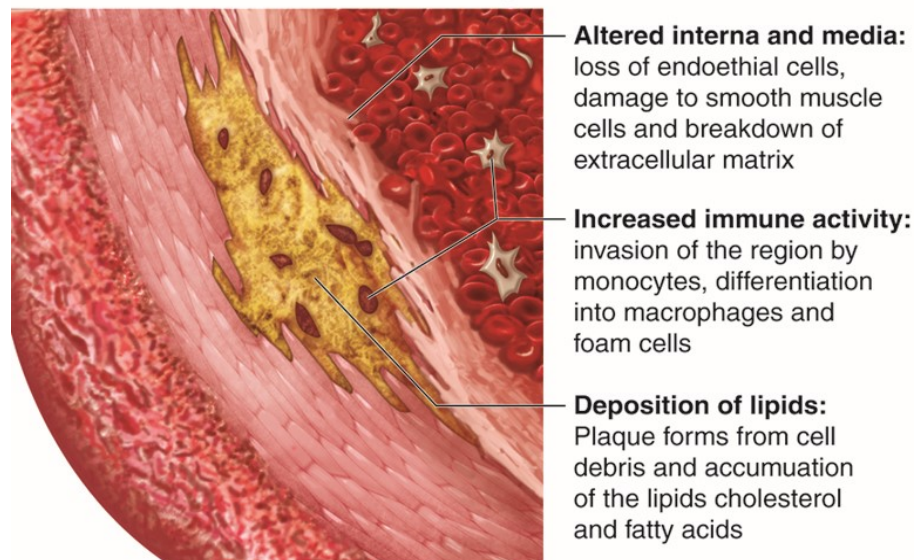


Fig. 5.5: Fatty streak in atherosclerosis.

Fatty streaks appear at 11-12 years and fibrous plaques appear at 15-30 years and they appear at the same anatomic sites as fatty streaks, indicating that fibrous plaques are a result of fatty streak

(iii) Plaque formation

Plaque is formed when the body's lipid removal systems are ineffective in atherosclerosis. Foam cells die before they can remove lipids, and inside the expanding yellow streak, a core of necrotic cells forms. Collagen enters the mass and begins to form a meshwork with other extracellular matrix materials in an attempt to repair the damage. Thus, the yellow streak is turned into an atherosclerotic plaque at this point (Fig. 5.6).

Plaques are disorganised masses of fatty substances, cholesterol, cellular waste products, calcium, and fibrin deposits that are covered by a white fibrous coating. As it accumulates in the arteries, the artery walls thicken and stiffen. In atherosclerosis, plaques are thick abnormal patches that form generally in scattered region of innermost layer of arteries.

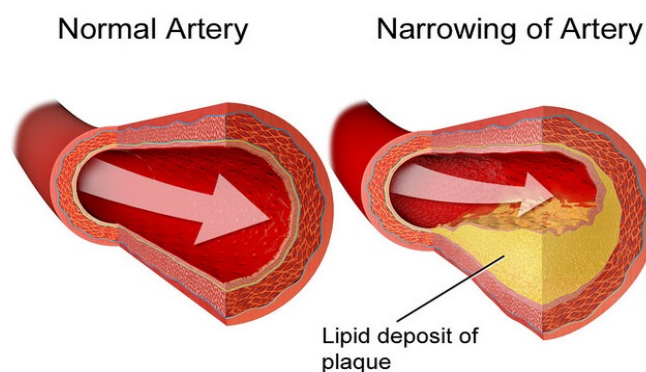


Fig. 5.6: Normal artery and Atherosclerotic artery in which plaque build-up within inner wall of artery.

(Image source: <https://commons.wikimedia.org/wiki/File:Atherosclerosis.jpg>).
Author-Blausen.com staff courtesy of Oregon State University

(iv) Plaque Destabilizers

Atherosclerotic plaques thicken over time. The plaques are disorganized and weak on the inside of artery. A network of small blood vessels grows into the enlarging plaque as part of the local repair efforts. Because of the inflammatory process, which dilates blood vessels to allow more easy passage of white blood cells, macrophages, and signaling chemicals, the new vessels tend to be leaky. As a result, hematomas and clots form inside the plaque. Some areas of the plaque are deprived of oxygen and nutrients. Local cells, primarily leukocytes and smooth muscle cells, die in these low-oxygen environments, forming more necrotic pockets. Calcium salts are slowly deposited in many tissues with chronic inflammation, making parts of the plaque brittle and causing arteriosclerosis, or artery hardening (Fig. 5.7).

The earliest abnormality is migration of blood monocytes to the subendothelium of the artery. Once there, they differentiate into macrophages. These cells accumulate cholesterol esters derived from plasma LDL. Some of the LDL may be taken up via pathways distinct from the classical LDL receptor pathway. For instance, receptors that mediate uptake of acetylated LDL or LDL complexed with dextran sulfate have been described and these are not regulated by cellular cholesterol content. Distortion of the sub endothelium leads to platelet aggregation on the endothelial surface and release of platelet-derived mitogens such as platelet derived growth factor (PDGF). This is thought to stimulate smooth muscle cell growth. Death of the foam cells results in the accumulation of a cellular lipid that can stimulate fibrosis. The resulting atherosclerotic plaque narrows the blood vessel and serves as the site of thrombus formation, which precipitates myocardial infarction (heart attack).

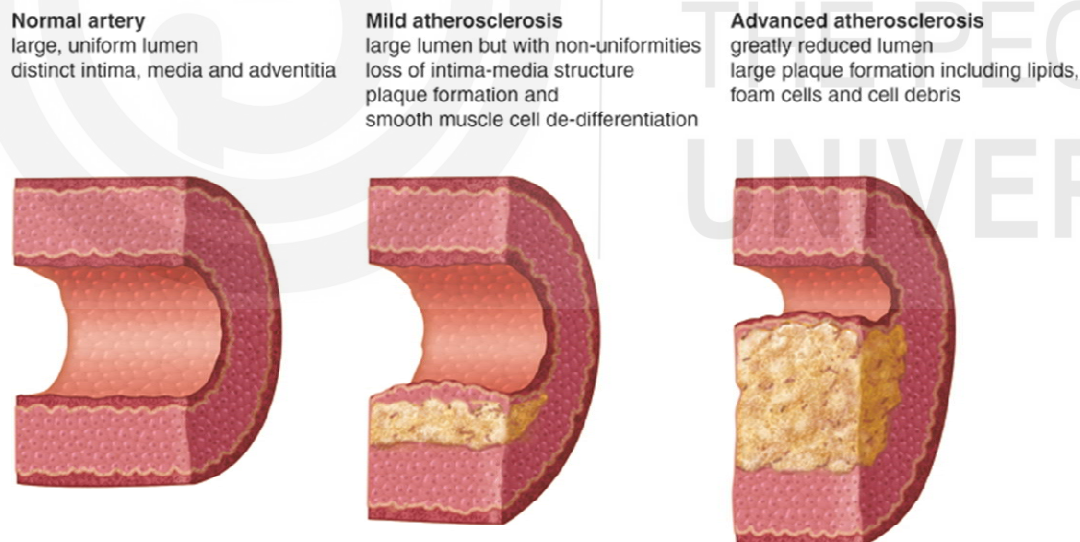


Fig. 5.7: Stages of atherosclerosis.

Image credit: <https://pressbooks.ccconline.org/bio106/chapter/cardiovascular-homeostasis/>

5.4.1 Role of Lipids in Atherosclerosis

The various lipids and lipoproteins are associated to the process of atherosclerosis. Atherosclerosis is caused by an abnormal level of LDL cholesterol, which is a key component of lipid. Lipids are bound to lipoproteins and transported to various tissues where they are used for a variety of

functions including energy utilization, steroid hormone synthesis, and bile acid formation. Lipids (cholesterol, triglycerides, and phospholipids) and apolipoprotein, a protein component, make up lipoproteins. LDL cholesterol, also known as low-density lipoprotein (LDL) cholesterol, is a type of fat that circulates in the bloodstream, transporting cholesterol around the body to where it is needed for cell repair and depositing it inside artery walls. Because cholesterol and triglycerides are insoluble in water, they must be bound to proteins in order to circulate in the hydrophilic blood. LDL is the most abundant atherogenic lipoprotein in plasma and the primary source of cholesterol accumulated in the arterial wall. The plasma levels of LDL-C are metric of the amount of cholesterol carried by LDL particles. Scientific research confirmed that elevated plasma level of LDL-C are linked to an increased risk of atherosclerotic disease. Diabetes, hypertension, hypertriglyceridemia, and atherosclerosis are all commonly associated with it.

The elevated level of lipoprotein in blood above normal level is called the Hyperlipidemia. Hyperlipidemias are disorders of the lipid metabolism. Higher level of lipoproteins usually is determined by measuring plasma level of triacylglycerol and cholesterol and are classified based on the class of lipoproteins that is elevated. Type III hyperlipidemia is caused by ApoE mutations that prevent chylomicron and VLDL remnants from being absorbed. Atherosclerosis is more likely in these patients.

Oxidized low-density lipoprotein (Ox-LDL) is a primary inducer for the progression of atherosclerotic plaque within blood vessels. It can also reduce the production of nitric oxide (NO) whose deficiency enhances atherosclerosis and blood pressure. Diabetes also promotes inflammation by the formation of advanced glycation end products that interact with endothelial receptors.

The high levels of blood cholesterol (hyperlipidemia), particularly LDL cholesterol, likely to cause heartdiseases and further leads to heart attacks and strokes. The majority of our body's cholesterol is LDL (low-density lipoprotein), also known as "bad" cholesterol. LDL cholesterol levels that are too high put us at risk for heart disease and stroke. CVDs (atherosclerosis and cardiac heart disease) are directly related to plasma LDL cholesterol levels and inversely related to plasma HDL cholesterol levels. This explains why the former is frequently referred to as "bad" cholesterol (LDL) and the latter as "good" cholesterol (HDL), despite the fact that there is only one cholesterol chemically.

SAQ 3

Fill in the blanks:

- i) Atherosclerotic plaques are filled mainly with.....
 - ii) Atherosclerotic plaques are likely to accumulate.....
 - iii) Foam cells are.....
 - iv) Plaque is composed of
 - v) The first step in the pathogenesis of atherosclerosis is
-

5.5 COMPLICATION AND RISK FACTORS

Atherosclerosis causes tissue damage throughout the body; it can cause

- blockages in the carotid arteries can reduce or block blood flow to the brain, resulting in a stroke.
- atherosclerotic obstructions in the intestines (Ischemic bowel).
- Atherosclerotic obstructions in the coronary arteries cause heart attacks
- Aneurysms.
- Angina.
- Chronic kidney disease.
- Coronary or carotid heart disease.
- Heart attack.
- Heart failure.
- Peripheral artery disease.
- Stroke.

Risk factors

The causative agents of atherosclerosis are abnormal cholesterol levels, hypertension, smoking, diabetes, elevated levels of inflammatory markers, obesity, family history, and an unhealthy diet (Fig.5.7). The following factors may include:

- Obesity and Diabetes
- Obstructive sleep apnea
- A family history of heart disease at a young age
- Lack of physical activity
- High-fat diet
- Hypertension
- Decreased HDL and LDL oxidation

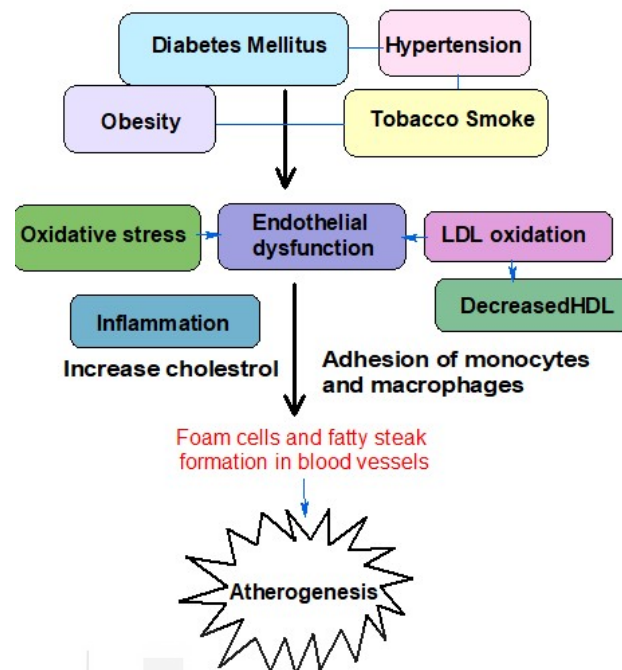


Fig. 5.7: Causative agents of atherosclerosis.

The chest pain, high blood pressure and leg cramps while walking are the early symptoms of atherosclerosis.

Prevention and diagnosis

Lifestyle changes, medication and surgery can help in preventing complications. These are some suggested for management of the cardiovascular disorders (CVDs).

- Avoid smoking
- Consuming nutritious foods
- Regular physical activity
- Keeping a healthy weight
- Keeping track of and maintaining a healthy blood pressure
- Monitoring and maintaining normal cholesterol and blood sugar levels.
- Low-saturated-fat diets and aerobic exercise.

Diagnosis

Patients with heart diseases are evaluated using a history, physical examination, blood pressure measurement, fasting lipid profile, plasma glucose, and HbA1c. CT Angiography is frequently used as a preliminary screening test. Catheter-based tests such as intravascular ultrasonography, angiography, plaque thermography, elastography, and immunoscintigraphy are also used as diagnostic procedures. CRP and LP-associated phospholipase A2 are serum inflammatory markers that predict cardiovascular events. Angiography, USG, CIMT, and MRI are some other imaging studies that can detect plaque.

5.6 SUMMARY

- Cardiovascular diseases (CVDs) are a group of heart and blood vessel disorders. Both conditions have an impact on the heart's normal function. People nowadays are afflicted with these diseases on a regular basis.
- The most common diseases are coronary artery disease, stroke, myocardial infarction, hypertension, and atherosclerosis.
- Atherosclerosis is the leading cause of death globally. It is commonly associated with fatty deposits in the arteries, which further leads to formation of blood clots within blood vessels.
- In atherosclerosis, the large arteries become hardened and narrowed due to deposition of cholesterol, inflammatory cells, debris and blood cells.
- Moenckeberg medial calcific sclerosis is characterized by the hardening of small to medium-sized arteries. Small artery calcification is referred to as arteriolosclerosis.
- Atherosclerosis is characterized by deposition of fat plaque within wall of blood arteries. The plaque narrows and stiffens the inside of the arteries, allowing less blood to reach the heart. It is commonly referred to as a "hardening" or furring of the arteries. Severe plaque buildup can lead to a heart attack or stroke. This occurs when a section of the heart does not receive enough oxygen.
- It is caused by the formation of multiple atheromatous plaques within the arteries. Oxidized low-density lipoprotein (Ox-LDL) is a primary inducer for atherosclerotic plaque progression.
- Platelets, cholesterol, other cells, and debris accumulate in the damaged inner endothelium wall of blood arteries. Fat deposits and accumulates in and around these cells over time.
- An atheroma, or fatty plaque, is composed of bloodcells, fat, debris, and connective tissue. The larger the plaque, the greater its impact on the size of the arterial lumen, or the area through which blood flows. If the vessel wall becomes overly thickened as a result of a large atheroma or multiple atheromas, blood flow decreases, reducing oxygen supply to the body's organs.
- Atherosclerosis is the underlying cause of heart attacks and strokes. When lesions obstruct blood flow, symptoms develop. When plaques grow, the arterial lumen narrows, resulting in transient ischemic symptoms, stable exertional angina, intermittent claudication, unstable angina, infarction, ischemic stroke, limb pain at rest, aneurysm, arterial dissection, and sudden death.
- Abnormal cholesterol levels, high blood pressure, smoking, diabetes, family history, sedentary life style and an unhealthy diet can cause CVDs. Hypertension, diabetes, dyslipidemia, obesity, sedentary lifestyle, family history, oxidative stress and smoking are all important risk factors for CVD.
- Reducing alcohol, stop tobacco smoking, avoid high fat diet, and regular physical activity (walking and Yoga) and taking proper medicine can help in preventing complications of heart disorders.

5.7 TERMINAL QUESTIONS

1. Write short notes on cardiovascular disorders.
2. Define atherosclerosis and its types.
3. Discuss the different development stage of atherosclerosis.
4. Discuss the biochemical relationship of fat with heart diseases.
5. What are complications and risk factors of heart disorders?
6. Enlist the key factors by which you can reduce complications or maintain heart disorders.

5.8 ANSWERS

Self Assessment Questions

1.
 - i) Arrhythmia is a condition of heart in which heart beats either too slowly or too fast in an unorganised manner. It refers to the heart rhythm disorders.
 - ii) Congestive heart failure is chronic heart diseases in which the heart is unable to pump blood with proper pressure.
 - iii) Hypertension is the condition of heart in which blood pressure remains consistently higher than normal BP (120/80mmHg). In hypertension, blood pressure against wall of blood artery remains high.
2.
 - i) The scientist Felix March
 - ii) Arteriolosclerosis refer to loss of elasticity of medium and small blood vessels (arteries and arterioles). It is characterized by hardening of the arteriole's walls due to deposition of material. while Monckeberg medial calcific sclerosis is a form of atherosclerosis where calcium deposits around the middle wall of blood artery ((the tunica media)
 - iii) Arteriosclerosis
 - iv) Atherosclerosis
3.
 - i) Extracellular lipid, **mostly** cholesterol and its ester
 - ii) Foam cells are lipid-laden macrophages which have high amount of cholesterol (LDL). They are cholesterol containing cells.
 - iii) Plaque consists fatty substances, cholesterol, cellular waste products, calcium, and fibrin.
 - iv) Lipid retention

Terminal Questions

1. Please refer to 5.2
2. Please refer to 5.3.1
3. Please refer to 5.4
4. Please refer to 5.4.1
5. Please refer to 5.5