ATHEROSCLEROSIS: THE SILENT ENEMY

WHAT IS ATHEROSCLEROSIS?

Atherosclerosis is a health condition that affects a significant number of people in the United States and around the world. It still accounts for the greatest number of non-commutable disease deaths.

- Atherosclerosis is considered the most common vascular condition.[4]
- It is estimated 17.5 million people die each year due to cardiovascular complications.
- Atherosclerosis accounts for 31% of deaths around the world.[4]
- Cardiovascular disease is the leading cause of death in the Western population.[3]
- Atherosclerosis starts at a young age and symptoms show later in life.
- Due to its silent development, atherosclerosis may be difficult to diagnose and treat at its early stage. By the time this condition is diagnosed, it may be harder to treat.
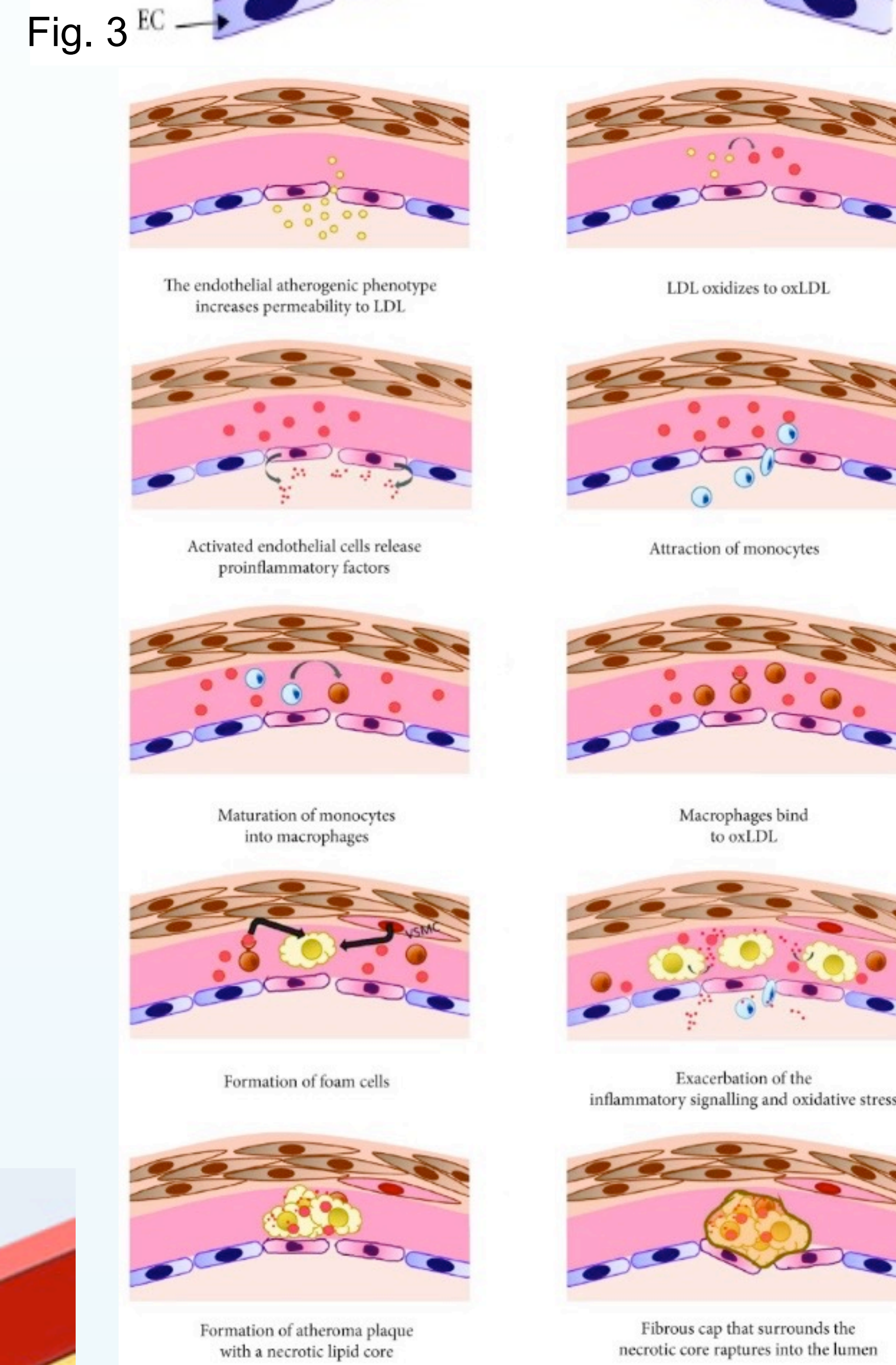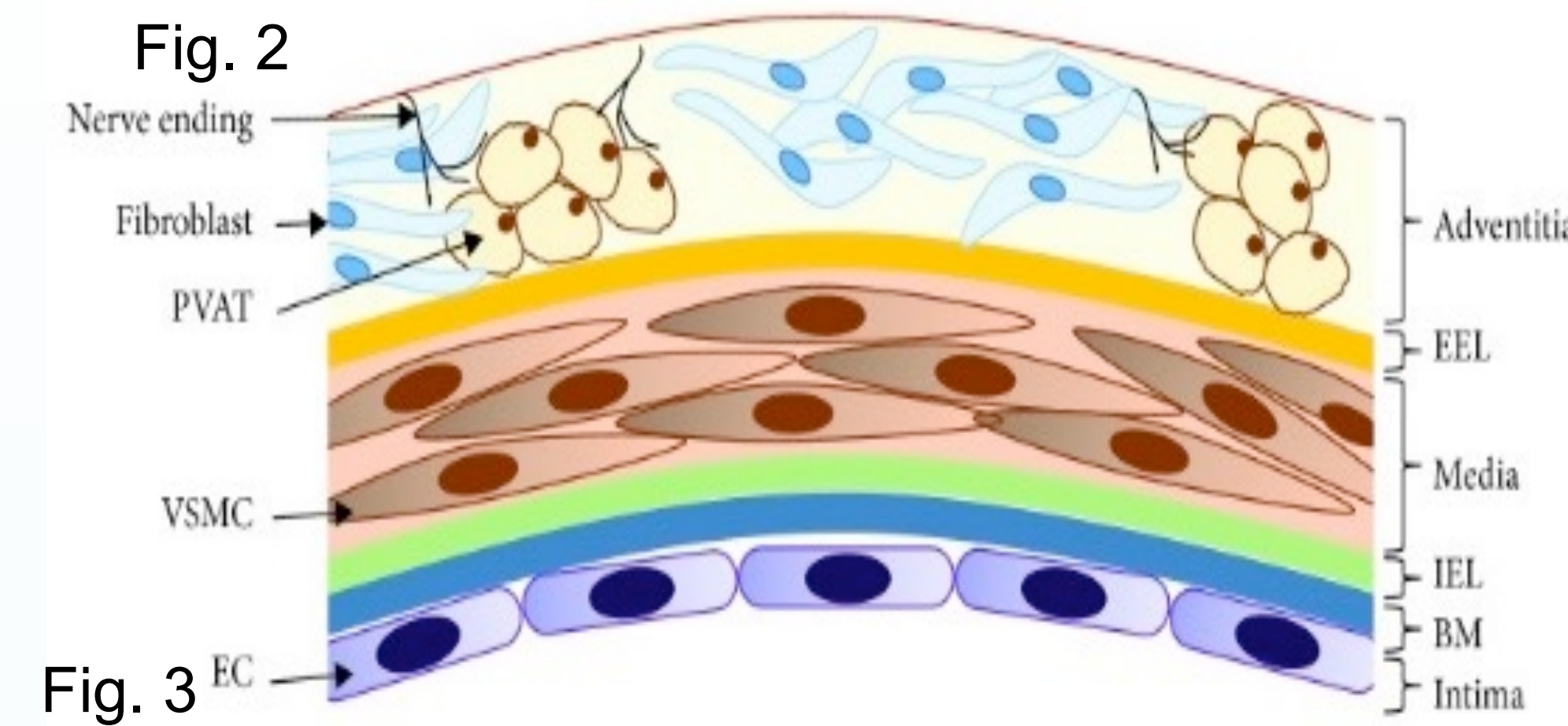
All of the factors mentioned above make it extremely important to create effective programs to prevent atherosclerosis. Prevention is the best way to deal with this condition.The reduction of risk factors is the most efficient and low cost measure to prevent atherosclerosis and the detrimental events of cardiovascular disease.[1]

Fig.1

LDL deposits cholesterol in the artery walls and starts the process of atherosclerosis.

Atherosclerotic plaque

LDL "Bad" Cholesterol

RESEARCH

Research shows atherosclerosis is a progressive inflammatory disease that effects the circulatory system from a young age.[1] Its latency is several years long, and the clinical effects are not observed until many years later. This disease mainly affects the walls of large and medium size arteries. Some of the major arteries affected include the aorta, carotid, and coronary arteries. The irregular blood in these areas leads to changes in the arterial wall. Some of the factors that cause atherosclerosis include hypercholesterolemia, hyperglycemia, obesity, hypertension, smoking, and aging.[1]

Fig. 2

Nerve ending — Adventitia
Fibroblast
PVAT — EEL
— Media
VSMC
— IEL
— BM
Fig. 3 EC — Intima

The endothelial atherogenic phenotype increases permeability to LDL.

LDL oxidizes to oxLDL.

Activated endothelial cells release proinflammatory factors

Attraction of monocytes

Maturation of monocytes into macrophages

Macrophages bind to oxLDL

Formation of foam cells

Exacerbation of the inflammatory signalling and oxidative stress

Formation of atheroma plaque with a necrotic lipid core

Fibrous cap that surrounds the necrotic core raptures into the lumen

DEVELOPMENT

Atherosclerosis is known to affect areas that experience low, turbulent, or oscillatory shear stress like branches, curvatures, and bifurcations of these major blood arteries. One of the earliest changes seen in the atherosclerosis formation process is the endothelium becomes more permeable to lipoproteins near points where major arteries branch and bifurcate.Laminar flow and high shear stress protects agains atherosclerosis. Shear stress, circumferential stretch, and high intraluminal pressure causes the activation of gene expression, which leads to changes in certain biochemical pathways.[1] The higher permeability allows lipids to cross the intima layer in regions where blood flow is irregular.. The uptake of lipids like low-density lipoprotein (LDL) cholesterol causes atherosclerosis. [1]The LDL is converted to oxidized LDL (oxLDL) and damages the endothelium, which triggers the inflammatory process.[1] The inflammatory response leads to the expression of molecules that attract monocytes to the damaged atherosclerotic lesion. The monocytes mature into pro-inflammatory macrophages.[1] The macrophages become foam cells. The final process involved in the formation of plaque is the formation of a permanent and more stable encasing of the atherosclerotic lesion. The encasing is a highly calcified structure that replaces the temporary fibrotic cap. The formation of this cap is an active, highly regulated vascular mineralization.[4]

WHAT CAUSES ATHEROSCLEROSIS?

Two of the main atherosclerosis formation factors are inflammation and immunity. These two events combined are involved in the formation and complications of atherosclerosis lesions. Dietary habits are known to exacerbate the formation of atherosclerotic plaque.[2] The consumption of food containing high levels of fat and cholesterol increases the risk of atherosclerosis.[2] It is known that in the absence of other risk factors, elevated cholesterol can cause atherosclerosis to develop.

The Lifestyle Heart Study, for example, looked at the effect of diet on atherosclerosis by looking at how a low-fat vegetarian compared a standard diet affected patients for one year. Participants who had a low-fat vegetarian diet presented with:

- decreased coronary atherosclerosis when studied using angiography
- 91% reduction of severe pain in the chest, shoulders, arms, and neck also known as angina.[2]

Patients on the standard diet, however, showed a 186% increase in the frequency of angina.[2] The "Western" diet, trans-fatty acids, and high glycemic index diet have a detrimental effect.[2]
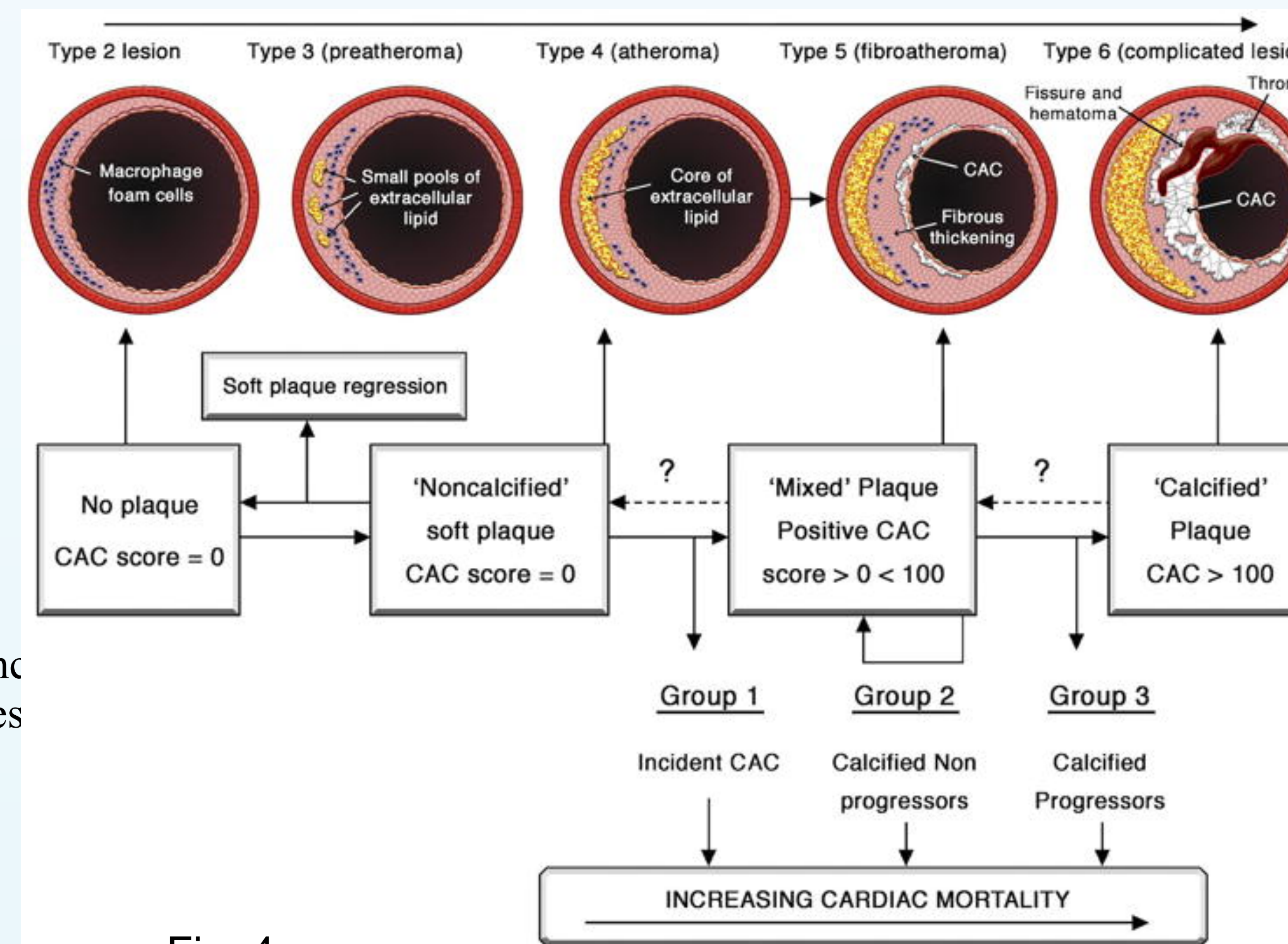

Fig. 4

Diagram depicting the progression of coronary atherosclerosis with age. By the teenage years, there is almost universal appearance of type 3 lesions in the aorta.[6] With increasing number of risk factors and age and ensuing endothelial damage, there is progressive growth in atheroma size. Calcification occurs in some of these lesions and leads to increasing calcium deposition with time, which is readily appreciated by non-contrast cardiac CT.

Studies clearly show the connection between low-density lipoprotein cholesterol (LDL-C) and atherosclerotic cardiovascular disease (ASCVD).[5] In addition, abnormal level of LDL-C is known to be the origin of ASCVD. It is dangerous to carry high levels of LDL-C from birth onward. The results of these studies show that lowering LDL-C to under 70 mg/dL decrease the chance of ASCVD events.[5] Researchers were able to conclude that the benefits of reducing LDL-C showed linear correlation. The reduction of LDL-C by 40 mg/dL reduced ASCVD events by 20%.[5] Studies have also shown that plaque growth occurs when LDL-C levels are above 70-90 mg/dL, and regresses when lower than these levels.[5] These studies have proven that early treatment of high LDL-C levels is important.[5]

IMAGING TO DETECT CALCIUM

Detection of atherosclerotic plaque has improved significantly over the years. Cardiac computed tomography angiography (CCTA) has become one an instrumental imaging modality to detect and diagnose people with suspected coronary artery disease (CAD). Non-contrast cardiac CT scans have also become an important tool to diagnose calcium in the arteries[6]. These scans are known as Coronary Artery Calcium Score CACS helps to show the increased risks of:

1. Coronary events
2. Heart failure
3. Dementia
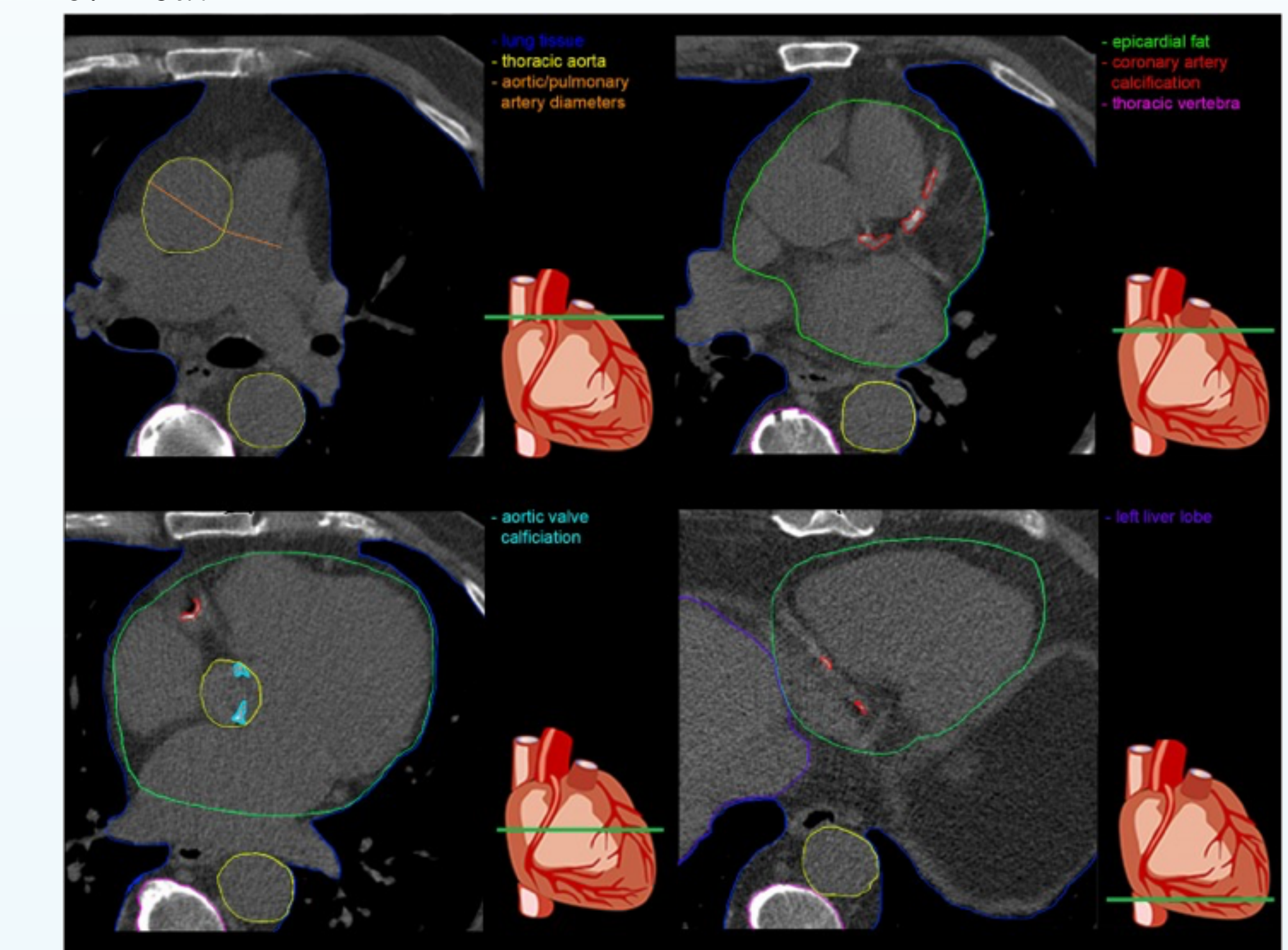4. Cancer
5. Kidney Disease
6. Death

Fig. 5

Imaging markers on non-contrast coronary calcium scans. Four slices of a coronary calcium scan of a single patient showing the heart at different levels with, in colour, the different tissues from which the potential imaging markers may be obtained

There is a number of facilities that offer comprehensive screenings to diagnose and prevent the effects of Coronary Artery Disease (CAD). CAD progresses slowly and silently. Symptoms appear when the disease is in its advanced stage. It is recommended to have a heart screening at age 40 for men and 45 for women. Particularly if there is history of CAD in the family. A proactive approach helps patients prevent the detrimental or even fatal effects of CAD. The screening includes eduction about risk factors that can be eliminated or reduced such as smoking, high blood pressure control, and a better diet. The screening program will include:

- Calcium CT score
- Blood Preassure
- BMI (Body Mass Index)
- Cholesterol and blood sugar check
- Carotid artery screening
- Aortic aneurysm screen
- Ankle brachial screen

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