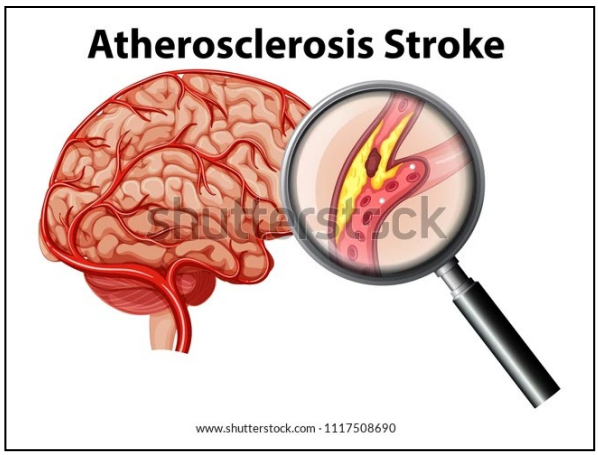
Atherosclerosis is caused by **“Chronic Inflammation”**, not cholesterol, and driven by an innate immune response.



How does inflammation linked with heart disease and stroke?

(New Concept)

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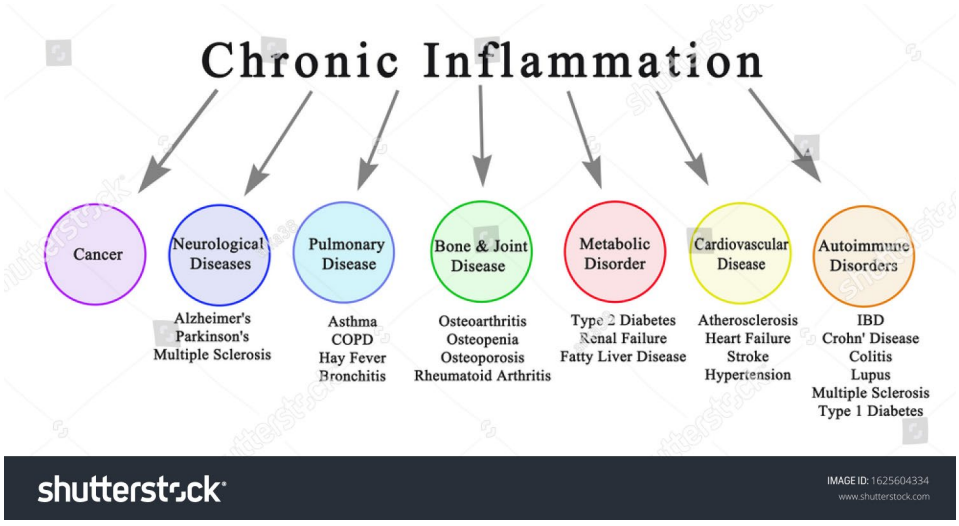
“Inflammation” is the process by which the body responds to any form of injury or infection, and its manifestations are redness (opening up minute blood vessels to bring in cellular and hormonal material for healing), swelling (increase body fluids to stack healing material), among other biochemical changes. It can happen anywhere- on the skin, within the body, and even inside arteries. In fact the scientists are learning to understand that inflammation may play the initial part in all diseases, including atherosclerosis (hardening) of arteries with plaque formation.

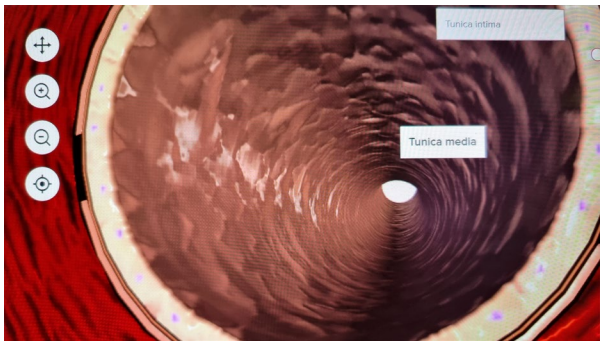


Scientists are learning to understand that inflammation may play the initial part in all diseases, including atherosclerosis (hardening) of arteries with plaque formation.

These inflammatory changes are believed to occur in the inner lining and possibly in the muscle layers of the arteries, especially in areas where the impact of the blood turbulence is most affected.

Contemporary paradigm of peripheral and intracranial vascular hemodynamics considers physiologic blood flow to be laminar. Transition to turbulence is considered as a driving factor for numerous diseases such as atherosclerosis, stenosis and aneurysm (Ref: Saqr, K.M., Tupin, S., Rashad, S. *et al.* Physiologic blood flow is turbulent. *Sci Rep* **10,** 15492 (2020). https://doi.org/10.1038/s41598-020-72309-8)

Such trauma causes tiny cracks on the inner lining which initiates the onset of inflammation. Brushing the inner lining of an artery with a tooth brush, will show the same inflammatory picture.



Inner lining of a blood vessel where cracks can occur due to turbulence.

For many years we were given the description that the buildup of plaque commences with fatty streaks within an artery leading to blockage and heart attack or stroke. This plaque become clogged by a blood clot and starves the heart with oxygen rich blood. It is observed that this theory is far from the truth as these types of blockages cause only about 3 out of 10 heart attacks.

In most heart attacks the coronary arteries are not severely narrowed by plaque. The researchers believe that vulnerable plaque may be buried inside the artery wall and may not always bulge out and block the blood flow through the coronary artery. This observation made the researchers to look at how inflammation affects the arteries, and whether inflammation could lead to a heart attack or stroke. **What they found was that inflammation was the key factor in the initiation of the plaque and not LDL cholesterol, once believed to be**. This vulnerable plaque was filled with different cell types that help with blood clotting, and the cholesterol found in them was just bystanders.

Pathogenesis of atherosclerosis (hardening of arteries with plaque formation) is associated with other chronic infections like rheumatoid arthritis, ankylosing spondylitis, polymyalgia, lupus and other inflammatory rheumatic diseases which includes- psoriatic arthritis, and these latter inflammatory diseases also cause accelerated atherosclerosis associated with a high rate of death from heart disease. These diseases have a greater susceptibility to atherosclerosis. Atherosclerosis is also a normal aging factor in normal people, without any inflammatory condition as described above.

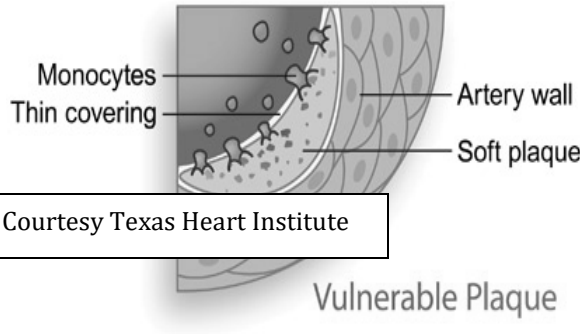
A team of researchers in Norway and the United States affiliated with Cleveland Clinic Foundation and Brigham and Women's Hospital in Boston, focused on the aortas of recent recipients of coronary bypass graft surgery, and compared biopsy specimens from patients with inflammatory rheumatic disease with those from patients without such disease. . Their study, presented in the

June 2007 issue of Arthritis & Rheumatism (http://www.interscience.wiley.com/journal/arthritis), affirms inflammatory rheumatic disease and smoking as independent predictors of vessel wall inflammation. The vascular inflammation might be a factor that promotes atherosclerosis and the formation of aneurysms.

Presently, and in the past it was believed that LDL cholesterol manufactured in the liver for the daily metabolic and endocrine requirements caused the atherosclerosis leading to heart disease and stroke.

" Can we believe that the very antioxidant cholesterol the liver manufactures for one's well being and survival is responsible for the inevitable atherosclerosis that occurs in arteries?"

The theory goes that LDL-cholesterol is good until it is made "bad" by the free radicals" in the blood stream. A far fledges theory to promote "statins" to reduce beneficial cholesterol in the blood stream by the giant U.S.companies through researchers and doctors to enrich themselves through such marketing.



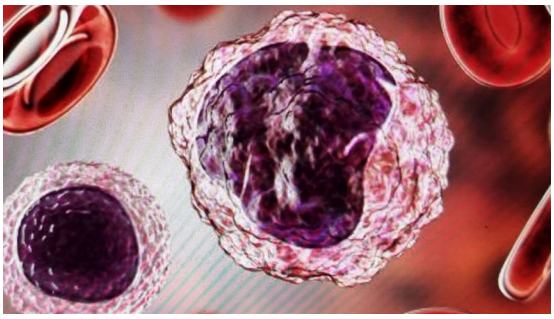
Courtesy Texas Heart Institute

What causes vulnerable plaque?

Cytokines cause inflammation.

This would be the million-dollar question. The fat droplets floating in the blood stream are absorbed by the arterial inner lining causing release of proteins (called cytokines) that lead to inflammation.

These cytokines make the artery wall sticky, which attracts immune-system cells, called ***monocytes*** present in the blood. The monocytes creep into the arterial wall and turn into larger cells called ***macrophages.*** These scavenging large cells begin to soak up fat droplets. It is these fat filled macrophages, it is believed, form plaque with a thin covering.


Monocytes in the blood vessel wall

When this inflammation is combined with other stresses, such as high blood pressure, the thin covering over the plaque can rupture and bleed.

"The blood cells, mainly platelets get stuck to the sticky cytokines and clumping of these cellular material forms a clot large enough to block the artery."

Dr Dwight Lundell past Chief of Staff and Chief Surgery at Banner Heart Hospital has this to say-

"The only accepted therapy was prescribing statin medication to lower cholesterol and a diet that severely restricted fat intake. These recommendations are no longer scientifically or morally defensible. The discovery a few years ago that **inflammation in the artery wall** is the real cause of heart disease is slowly leading to a paradigm shift in how heart disease and other chronic ailments will be treated.
The long-established dietary recommendations have **created epidemics of obesity and diabetes,** the consequences of which dwarf any historical plague in terms of mortality, human suffering and dire economic consequences.

"Despite the fact that 25% of the population takes expensive statin medications and despite the fact we have reduced the fat content of our diets, more Americans will die this year of heart disease than ever before".

Statistics from the 'American Heart Association' show that 75 million Americans currently suffer from heart disease, 20 million have diabetes and 57 million have pre-diabetes. **These disorders are affecting younger and younger people in greater numbers every year.**
Simply stated, without inflammation being present in the body, there is no way that cholesterol would accumulate in the wall of the blood vessel and cause heart disease and strokes. Without inflammation, cholesterol would move freely throughout the body as nature intended. It is **inflammation** that causes cholesterol to become trapped."

It is bringing to light that diets **low in fat** is not what the doctors should recommend when the culprits are **polyunsaturated fats and carbohydrates** causing repeated injury to our blood vessels, resulting in heart disease, stroke, diabetes and obesity.

Overload of simple, highly processed carbohydrates (sugar, foods cooked with rice and wheat flour) and the excess consumption of omega-6 vegetable oils like corn, sunflower, and soybean found in many of our processed foods, are today considered as creating such chronic inflammatory changes in the inner lining of arteries. **Increase your load of Omega-3 foods and oil and reduce intake of Omega-6 foods and oils**

Colombo, Sri Lanka-Omega-6 city

Colombo is becoming a haven for many food outlets for starchy processed foods cooked in Omega-6 type of polyunsaturated oils. Look around the main and side streets, what you see are small unclean food outlets feeding the people with foods such as hoppers, pittus, indiappams, thosais', wadeis', godas' among others- all processed starchy foods prepared with oils like sun-flower, vegetable and corn. The more heart healthy oils - the omega-3 types like canola, monounsaturated oils like peanut, olive oil, and saturated coconut oils are far too expensive to be utilized in these cost cutting food outlets, and furthermore not available freely in our markets.

The richer elite class patronizes cleaner food outlets for their pastries, cakes, and rice packets, all using similar oils.

Most of these omega 6 types of oil are trans-fat sold in supermarkets to increase the shelf life of the oils. They reduce the immune response in the body and cause cancer in various organs.

Overload of highly processed carbohydrates and excess consumption of omega-6 vegetable oils are the biggest culprits of **chronic inflammation** and not valuable cholesterol manufactured in the liver (90%) and found in foods such as eggs, sea foods, and dairy products.

Assessing the degree of chronic inflammation by C reactive protein

Cardiologists can today measure the extent of chronic inflammation of blood vessels and the risk of heart attack or stroke, by performing a simple blood test to measure the level of a substance called **C-reactive protein** manufactured in the liver that increases with systemic inflammation.

C reactive protein is a marker that doctors use to measure inflammatory activity in the body. Studies show that the higher the C-reactive protein levels in the blood, the greater the risk of a heart attack. There is a more sensitive test called highly **selective (hs) C-reactive protein** assay to determine the risk of heart disease, available in most countries, including Sri Lanka.

Medicines like ACE inhibitors (high blood pressure medication) and aspirin appear to reduce inflammation in the body, which may prevent heart attacks in people who already have high C-reactive protein levels. Cholesterol lowering drugs called statins also have been found to lower C-reactive protein levels.

Chart showing Polyunsaturated fats

Omega-6	Omega-3
Sunflower oil Corn oil Cotton seed oil Sesame oil	Fish- Sardines, canned Mackerel, canned Salmon red and pink, canned Sword fish

Soybean oil Grape seed oil Evening Primrose oil Vegetable oils Margarine Breads Cereals Seeds Sunflower Sesame *Courtesy: Shamala Ratnesar- Omega-3 life program*	Spanish mackerel Tuna ,canned Mussels, Squid, Oysters, Scallops, Prawns Omega-3 enriched eggs Lean lamb and lean beef Mustard seed oil Canola oil Soybean oil Baked beans Red kidney beans Mushrooms, green beans Dark greeny vegetables-Purslane, Spinach, Leeks, Lettuce