Review on: Pathophysiology of Angina Pectoris

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Abstract- **Angina pectoris is a medical condition that occurs when your heart receives a decreased amount of oxygenated blood. Often, this occurs due to deposits of cholesterol clogging the blood vessels that carry blood to your heart. Patients who have angina pectoris are at a risk for having a heart attack, Chest pain behind the breastbone is the most common sign of angina pectoris. The discomfort may feel like pressure, squeezing, burning or tightness, reports the National Heart Lung and Blood Institute. The chest pain is most common during exercise, physical work or sexual activity. Emotional stress, cold weather and nightmares may also trigger an attack of chest pain. The best preventive measures one can take include-start an exercise program-stop smoking-decrease alcohol consumption-avoid stressful situation-avoid heavy and fatty meals. The best treatment of angina is drug therapy. The most common group of drugs used to treat angina is nitroglycerines. Nitroglycerin is available in various formulations. It can be taken by mouth, placed underneath the tongue and can even be given intravenously. Nitroglycerin has the ability to open up (dilate) blood vessel and allows more blood to the heart. Nitroglycerin is usually taken when one feels the chest pain coming. A tablet is placed underneath the tongue and within a few minutes the pain will disappear. In some cases, two tablets may be required. Nitroglycerin formulations are also available as an oral pill which must be taken 2-3 times a day. Beta blockers have been used to treat coronary disease for decades. They act by decreasing the work of the heart and thus decrease oxygen utilization.**

Keywords: **Angina pectoris, Myocardial ischaemia, Cholesterol, Nitroglycerin, Beta blockers.**

INTRODUCTION

Angina pectoris is a symptom that in appropriate circumstances indicates chest pain arising from the heart. The fundamental cause is often regarded as an imbalance between the supply and demand of the limiting substrate for the heart, namely oxygen. The belief is that such an imbalance is synonymous with the presence of myocardial ischaemia. The definition of ischaemia is surprisingly controversial. [1,2]

There are rarer causes of angina, such as anaemia, in which the oxygen content of blood is reduced, or aortic stenosis, in which the work of the myocardium is greatly increased. However, the cause is usually an imbalance between the work of the heart muscle, requiring the consumption of ATP, andlimitations to blood flow. By far, the most common pathological defect causing reduced coronary blood flow is obstruction due to atheromatous lesions in the coronary arteries. These lesions in the arteries develop in early life,[3] [4] slowly enlarge, and manifest themselves as angina or a cardiac event in middle to old age.

DEFINITION

Angina Pectoris is a kind of chest pain that arises from reduced or insufficient blood flow to the heart. Lack of sufficient blood flow means that your heart is not getting sufficient oxygen. The pain is mostly triggered by emotional stress or physical activity. Angina Pectoris is also known as Stable angina and this is the most common kind of angina. Stable angina has a predictable pattern of chest pain based on what you are doing when the pain is felt and can be tracked. Tracking stable angina can also help you manage its symptoms with case.

Angina mostly happens when the heart muscle requires more blood than it is receiving, for example, at the time of strong emotions or physical activity. Too much-narrowed arteries may let enough blood to reach heart when the demand for oxygen is low, but the heart requires more oxygen during physical exertion like exercise.[5]

TYPES

Three different kinds of angina have been identified.
- Stable Angina / Classic Angina
- Unstable Angina / Crescendo Angina
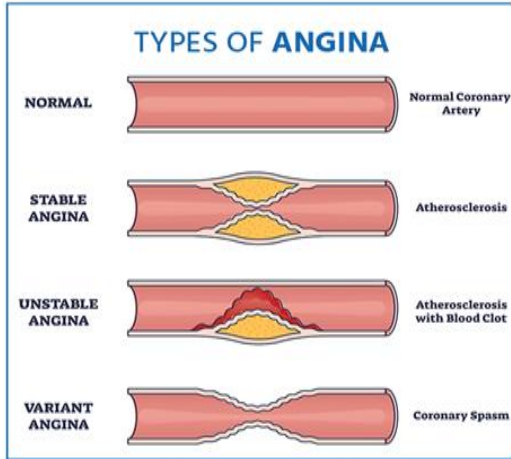- Variant Angina / Prinzmetal Angina

Fig no.1. Types of Angina

Stable Angina / Classic Angina
It occurs when the heart has to work harder than normal, during exercise, for example. It has a regular pattern, and if you already know that you have stable angina, you will be able to predict the pattern. Once you stop exercising or take medication (usually nitroglycerin) the pain goes away, usually within a few minutes.

Unstable Angina/ Crescendo Angina
It is more serious and may be a sign that a heart attack could happen soon. There is no predictable pattern to this kind of angina; it can just as easily occur during exercise as it can while you are resting. It should always be treated as an emergency. People with unstable angina are at increased risk for heart attacks, cardiac arrest, or severe cardiac arrhythmias (irregular heartbeat or abnormal heart rhythm).

Variant Angina / Prinzmetal Angina
It is also known as Prinzmetal angina, It often occurs while someone is resting (usually between mid-night and 8:00 in the morning), and it has no predictable pattern—that is, it is not brought on by exercise or emotion. This kind of angina may cause severe pain and is usually the result of a spasm in a coronary artery. Most people who have variant angina have severe atherosclerosis (hardening of the arteries), and the spasm is most likely to occur near a buildup offatty plaque in an artery. [6]

EPIDEMIOLOGY

As of 2010, angina due to ischemic heart disease affects approximately 112 million people (1.6% of the population) being slightly more common in men than women (1.7% to 1.5%).[7]
Angina pectoris is more often the presenting symptom of coronary artery disease in women than in men, with a female-to-male ratio of 1.7:1. It has an estimated prevalence of 4.6 million in women and 3.3 million in men. In one analysis, this female excess was found across countries and was particularly high in the American studies and higher among nonwhite ethnic groups than among whites. [8]

ETIOLOGY

Your heart muscle needs a constant supply of oxygen. The coronary arteries carry blood containing oxygen to the heart. When the heart muscle has to work harder, it needs more oxygen. Symptoms of angina occur when the coronary arteries are narrowed or blocked by atherosclerosis or by a blood clot. The most common cause of angina is coronary artery disease. Angina pectoris is themedical term for this type of chest pain.[9]
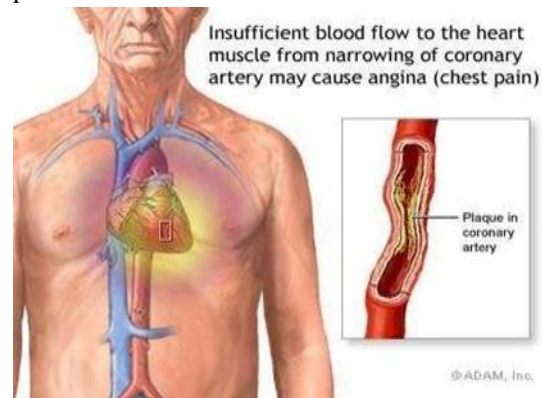

Fig no.2. Etiology of Angina

Stable angina is less serious than unstable angina, but it can be very painful or uncomfortable.There

are many risk factors for coronary artery disease. Some include:

- Diabetes
- High blood pressure
- High LDL cholesterol and low HDL cholesterol
- Smoking

Anything that makes the heart muscle need more oxygen or reduces the amount of oxygen it receives can cause an angina attack in someone with heart disease, including:

- Cold weather
- Exercise
- Emotional stress
- Large meals

Other causes of angina include:

- Abnormal heart rhythms (your heart beats very quickly or your heart rhythm is not regular)
- Anemia
- Coronary artery spasm (also called Prinzmetal's angina)
- Heart failure
- Heart valve disease
- Hyperthyroidism (overactive thyroid)[10]
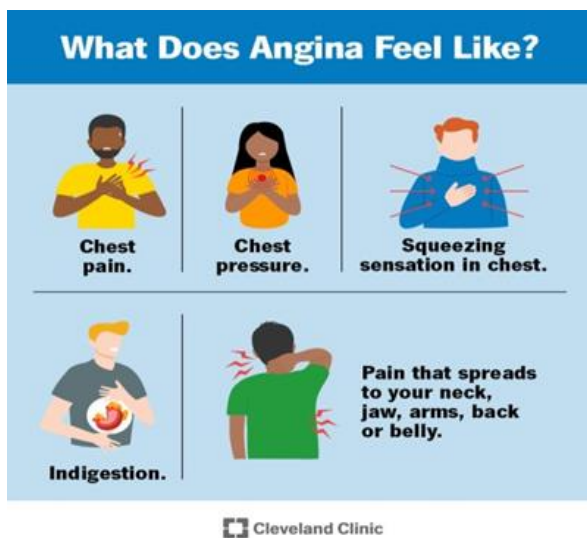
PATHOGENESIS

Fig no.3. Pathogenesis of Angina

Oxygen is delivered to the heart by larger surface vessels (epicardial vessels) and intramyocardial arteries and arterioles, which branch out into capillaries. In a healthy heart, there is little resistance to blood flow in the epicardial vessels. When atherosclerotic plaques are present, blood flow is impeded, but the process of auto-regulation can compensate to a degree. Auto-regulation is the dilation of the myocardial vessels in response to decreased oxygen delivery. Through auto-regulation, blood flow to the heart changes rapidly as a result of higher demand. The most important mediators involved in myocardial perfusion are adenosine (a potentvasodilator), other nucleotides, nitric oxide, prostaglandins, carbon dioxide, and hydrogen ions[.[11] Obstructions to the coronary blood flow can be fixed, as with atherosclerosis, or dynamic, as with coronary spasm. Some patients may have both characteristics, and this is termed *mixed angina*.

A single-cell endothelial layer separates the vascular smooth muscle from the blood. When intact, this vascular endothelium permits vasodilation and prevents thrombus and sclerotic plaque formation. The coronary artery endothelium synthesizes fibronectin, interleukin-1, tissue plasminogen activator, certain growth factors, prostacyclin, platelet-activating factor, endothelin-1, and nitric oxide (NO). NO is synthesized from L-arginine by nitric oxide synthase. NO then causes relaxation of the arterial smooth muscle. Loss of endothelial layer results in less NO and can occur because of mechanical or chemical assaults or from oxidized low-density lipoprotein (LDL). Endothelial function can be improved with angiotensin-converting enzyme inhibitors (ACEIs), statins, and exercise. The Canadian Cardiovascular Society developed a system of grading angina that is generally well accepted[12]

SIGNS AND SYMPTOMS

Angina itself is a symptom (or set of symptoms), not a disease. Any of the following may signal angina:

- An uncomfortable pressure, fullness, squeezing, or pain in the center of the chest
- It may also feel like tightness, burning, or a heavy weight.
- The pain may spread to the shoulders, neck, or arms.

- It may be located in the upper abdomen, back, or jaw.
- The pain may be of any intensity from mild to severe.

Other symptoms may occur with an angina attack, as follows:
- Shortness of breath
- Lightheadedness
- Fainting
- Anxiety or nervousness
- Sweating or cold, sweaty skin
- Nausea
- Rapid or irregular heart beat
- Pallor (pale skin)
- Feeling of impending doom

These symptoms are identical to the signs of an impending heart attack[13][14]

RISK FACTORS

- Angina is most often caused by CAD, most of the risk factors are the same. They include:
- High cholesterol
- High blood pressure
- Smoking
- Diabetes
- Obesity
- Lack of physical activity
- Age (greater for men over 45 years and women over 55 years)
- Family history of heart disease
- Stress and anxiety
- Sleep deprivation
- For women: a history of pre-eclampsia and pregnancy-related diabetes

It is also helpful to know what triggers your angina symptoms. Use the Seconds Count Tracking Your Angina Worksheet to record what you were doing each time before you had angina symptoms.
Here are some common triggers to monitor and avoid if possible:
- Very hot or very cold temperatures
- Big meals
- Physical activity
- Emotional stress

- Drinking (alcohol)
- Smoking [15]

DIAGNOSTIC TEST

Patient's Medical History
History of similar condition, high blood pressure, high cholesterol, diabetes, smoking, alcohol intake, obesity etc. in the patient is important as these are important risk factors for angina. Someone in the family may have heart disease or angina as these conditions may run in families.

Physical Examination
A complete physical examination includes assessment of weight, waist size, height (to assess Body mass index – BMI with respect to weight) and features of high blood cholesterollike spots over the eye lids or a hardened feel of the arteries at the wrist etc.[16]

Blood Tests
Routine blood tests are prescribed to detect anemia (that may raise the risk of angina), cholesterol and glucose in blood as well as liver and kidney functions.
Urine examination is also advised to check on the kidneys. Liver and kidney function tests may guide medication to be used as some medications may not be used in patients with disorders of these organs.

Electrocardiogram (ECG)
This is a record of the rhythms and electrical activity of the heart. The test is a painless one where small electrodes or patches are stuck on various parts of the chest of the patient and the electrical activity of the heart is recorded onto a strip of paper. Each heart beat has typical wave patterns and abnormalities of these waves (P, Q, R, S, T and U) may detect ischemia of the heart muscles in angina patients.[17]

Echocardiography
Echocardiography may be required to assess cardiac function, detect valve disease or cardiomyopathy as cause of angina.

Exercise Tolerance Test (ETT)
This is a similar test to ECG or EKG and is carried

out while the patient is made to exercise under supervision. This may be with a treadmill or an exercise bike. This is also called a treadmill test. This measures the amount of exercise that is required for the heart to develop symptoms of angina

Myocardial Perfusion Scintigraphy (MPS)
This test is performed alternatively to ETT when ETT results are not diagnostic. This test involves injection of a small amount of radioactive substance into the patient's blood.
This is then viewed using a gamma camera. This camera tracks the movement of the dye as it passes through the blood vessels of the heart and helps detects narrowing and obstructions. It is performed when the patient is at rest and also when he or she is on the exercise bike or treadmill.

Coronary Angiography
This is a more invasive test and may require a day of stay at the hospital. A thin flexible tube or catheter is threaded into a vein or artery at the groin (Femoral vein or artery) or at the arm (Brachial artery or vein). X rays are used to guide the catheter into the heart and coronary arteries. A dye is injected into the catheter to highlight the coronary arteries. Repeated X rays and films show up the site of blockages.

Other Tests for Angina
Other tests include Stress echocardiography, Multi slice CT scan, first-pass contrast- enhanced magnetic resonance (MR) perfusion (MRI) and MR imaging for stress-induced wall motion abnormalities. These tests show the heart function as well as detect the area of calcifiedor hardened arteries that is leading to symptoms of angina. [18]

TREATMENT

Pharmacological Management
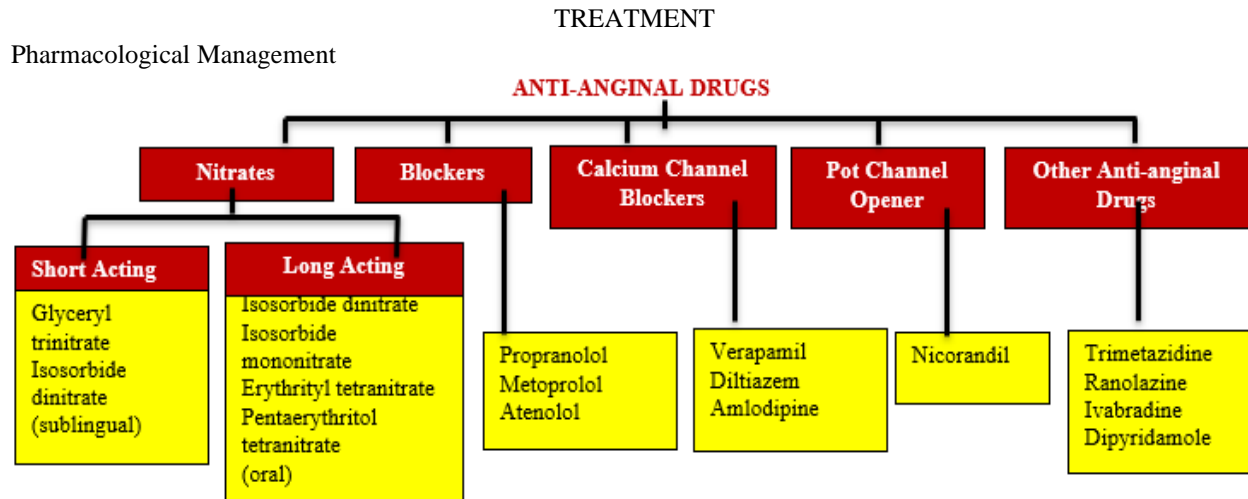
NON-PHARMACOLOGICAL, NON-MEDICAL, NON-SURGICAL THERAPIES FOR THE TREATMENT OF ANGINA PECTORIS

The treatment of angina pectoris as an important symptom of coronary artery disease is usually focused on restoring the balance between myocardial oxygen demand and supply by administration of drugs interfering in heart rate, preload, after load, and coronary vascular tone. For non responders to drug therapy or for those with jeopardized myocardium, revascularization procedures such as coronary artery bypass graft surgery (CABG) and percutaneous transluminal coronary angioplasty (PTCA) are at hand. However, these therapies cannot stop the disease process and, at longer terms, angina may recur. It is not always possible to revascularize all the patients who do not sufficiently react to medical treatment. In these group patients alternative therapies are more effective. A major difference between alternative therapies versus traditional therapies is that alternative therapy tends to look at the entire patient rather than simply treating a disorder as traditional treatments do. Some kinds of these therapies are applicable in all patients with

coronary artery disease irrespective of their symptoms and the other ones would be considered in patients with refractory angina who are not suitable for revascularization.

- Consume a Healthy Diet
- Achievement or maintaining an ideal body weight
- Prevention of excess weight gain
- Treatment of obesity-Although prevention and treatment of obesity both depends on the same principles of energy balance, the application of the principles is completely different. For treatment of obesity, a large reduction in calorie intake of about 500 to 1000 kcal per day, along with increased physical activity, can result in a loss of approximately 8- 10% of body weight over the relatively short period of about 6 months
- A diet rich in vegetables and fruits.[19]

SUPPLEMENTS

It is ideal to get the body nutritional needs in foods. When that is not enough, a registereddietitian may also start a series of supplements to make up for nutrients not getting through the diet. Some of the more popular supplements for both healthy and those at risk for coronary artery disease include antioxidants such as vitamins C and E, B-complex, omega-3 fish oil and coenzyme Q10.The American Heart Association recommends 2-4 grams of Omega-3 per day foranyone with high triglycerides and at least 1 gram per day for anyone with documented coronary heart disease. According to the results of many clinical trials performed to clear the role of dietary supplements in the prevention and /or slowing the progression of cardiovascular diseases, the long-term effects of most dietary supplements other than for vitamins and minerals are not known, so these agents should be prescribed under professional supervision of physician or a registered dietitian.[20] [21]

CONCLUSION

Prevalence of angina was found to be increasing with age and was found more in persons with low employment status (coolie workers, drivers, farmers). Stable angina was found to be more

prevalent among the population compared to unstable angina and variant angina. Angina was found to be more prevalent in males compared to females. All three types of angina was found to be more prevalent in males. This reflects male gender is an important risk factor for angina pectoris. Approximately half of the patients had hypertension, Diabetes mellitus, High cholesterol level and obesity. This is associated with stress, Life style changes and unhealthy food habits. Hypertension was found to be the most common risk factor for angina followed by Higher cholesterol level and Diabetes mellitus. Two risk factors, smoking and alcohol consumption were limited only in male. One risk factor, post menopause stage was limited only in female. Family history of CAD increases the chances of Angina in first degree relatives. 98% of the population had multiple risk factors. The drug pattern included anti platelet medication, anti-anginal drugs, statins and anti-coagulants. Most preferred medication was Anti platelet medication. Aspirin and clopidogrel were the most commonly used anti platelet drugs. Combination therapy was preferred more than treatment with individual drugs. Drug therapy in angina was associated with lot of side effects. The present study demonstrates a high prevalence of angina risk factors in the population. The incidence of angina is likely to increase further because of rapid urbanisation and its accompanying lifestyle changes. There is an immediate need to raise awareness among the general population about the risk factors, promote the correct diet and physicalactivity. We need to develop guidelines for screening and preventive therapeutic programs to identify and manage individuals with high risk for future events. Many patients experience frequent symptoms which reduces the quality of life. Alternative effective treatment of angina can have a beneficial impact on patient recovery.

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