Angina

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Purpose

The purpose of this course is to define angina, explain the different types, symptoms, precipitating factors, diagnostic procedures, and treatments.

Goal

Upon completion of this course, one should be able to:

- Describe the coronary artery system.
- Define angina.
- Describe and differentiate among 3 primary types of angina.
- List at least 5 precipitating factors for angina.
- Describe treatment options for angina.
- List and describe at least 3 different diagnostic procedures.
- Explain the PQRST method for questioning patients.
- List and describe at least 4 percutaneous/surgical procedures used for angina.

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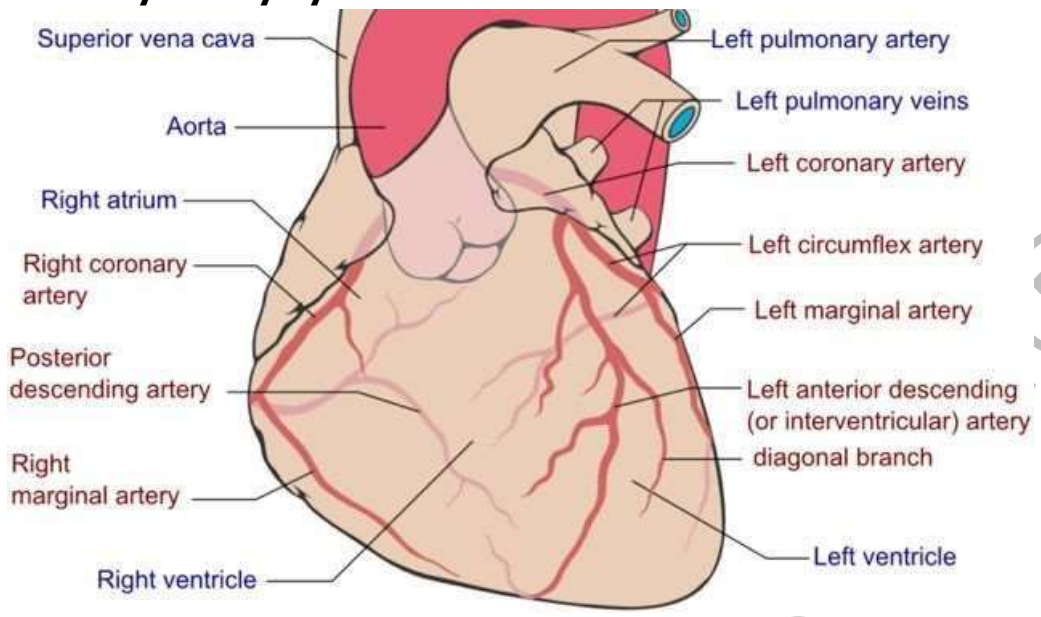
Introduction

Coronary artery system



Patrick J. Lynch, Medical Illustrator; C. Carl Jaffee, Cardiologist: Wikimedia Commons

The right and left coronary arteries branch off from the aorta, just beyond the aortic valve. These main arteries branch into others that wrap around the outside of the heart muscle, providing oxygen and nutrients:

- Right coronary artery branches into the posterior interventricular (descending) artery (supplying the walls of both ventricles) and the right marginal artery (supplying the walls of the right atrium and right ventricle).
- Left coronary artery branches into the left circumflex artery (supplying the walls of the left atrium and left ventricle) and the left anterior descending (supplying the walls of both ventricles). In order to function properly, the heart must continually beat, but it requires a constant supply of oxygenated blood. Branches of the coronary arteries feed myocardial capillaries, providing the oxygen the heart muscles needs. As people age, extra coronary anastomoses form between smaller coronary branches, providing collateral circulation. Angina (pain) results from ischemia or lack of adequate oxygen to the heart muscle.

What is angina?

Angina is a manifestation of coronary artery disease, which affects more than 16 million Americans and is the leading cause of death

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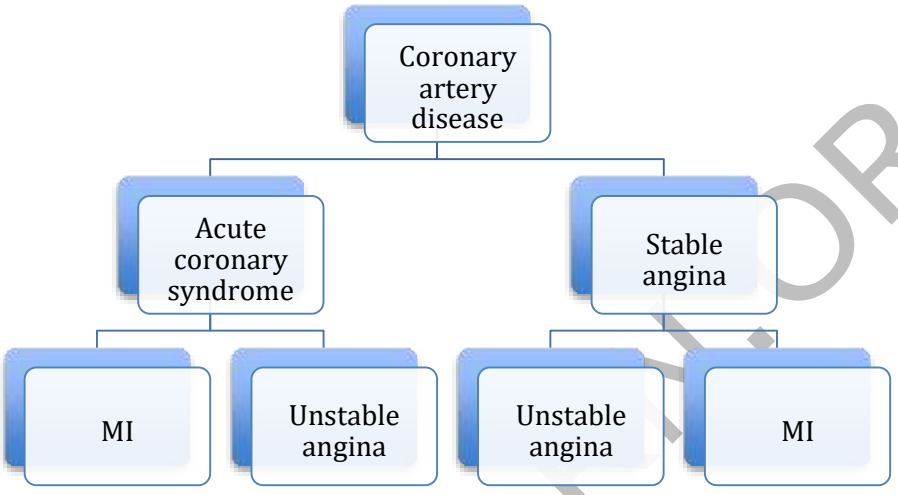
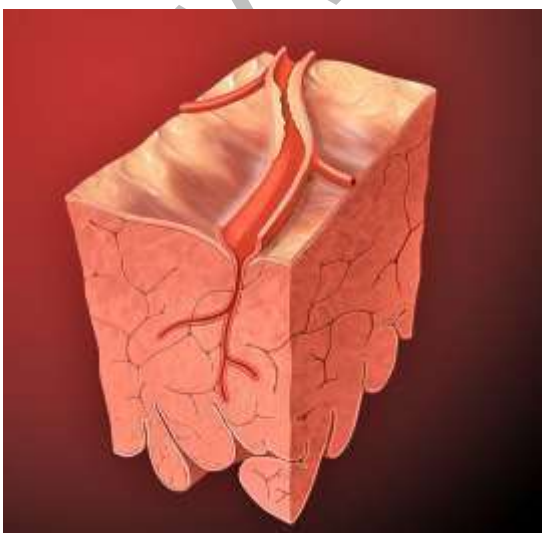
(1:5). The most common cause is atherosclerosis, with plaques building up in the lumens of the coronary arteries and interfering with blood flow and oxygenation of the myocardium. When ischemia is intermittent and can be reversed, it is referred to as stable angina pectoris. However, over time the lumen may narrow to such a degree that ischemia is prolonged and cannot be reversed, leading to acute coronary syndrome, which is characterized by unstable angina, myocardial infarction (when complete blockage occurs), and sometimes cardiac arrest.



By far the most common cause of angina pectoris is atherosclerosis, fatty deposits in the lining of arteries. These deposits form plaques with irregular surfaces that promote formation of clots. Over time, the arterial walls begin to degenerate and lose elasticity, becoming sclerotic and increasing risk of rupture.



However, other conditions may also impair blood flow. Severe myocardial hypertrophy, emboli, arteritis, and congenital anomalies may all result in angina. Non-coronary diseases that increase metabolic demands, such as anemia, hyperthyroidism, or paroxysmal tachycardia, may also cause angina.

In rare cases, no coronary cause can be found for angina. Angina occurs, but the coronary arteries appear patent. This condition is referred to as cardiac syndrome X and affects primarily females of post-menopausal age. Researchers believe syndrome X may be caused by changes in the microvasculature (capillaries) of the cardiac muscles, but these vessels are too small to detect on angiography. Despite the discomfort, syndrome X does not respond well to treatment but poses little danger to the heart and is not life threatening. Those with cardiac syndrome X may exhibit changes typical of coronary artery disease on stress testing, but angiography shows no blockage.

In some cases, ischemia of the heart muscle may occur without overt symptoms. Risk of silent ischemia increases with history of diabetes mellitus and hypertension. Even without pain, the risk of myocardial infarction relates to the degree of circulatory impairment.

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Angina: Precipitating factors	
Exertion	Exercise or other physical exertion related to work or other activities increases the heart rate and decreases duration of diastole, which interferes with circulation to the coronary arteries.
Temperature	Temperature extremes increase the heart's workload. Cold results in vasoconstriction, limiting coronary blood flow. Heat causes peripheral vessels to dilate and blood to pool in the skin, again limiting coronary blood flow.
Emotional changes	Strong emotions, such as anger or fear, stimulate the sympathetic nervous system and increase the pulse and the heart's workload.
Smoking	The nicotine in tobacco stimulates release of catecholamines, which increase heart rate and cause vasoconstriction, as well as decreasing available oxygen to the heart because of increased levels of carbon monoxide.

Stimulant drugs	Drugs, such as amphetamines and cocaine, increase the heart rate with subsequent decrease in duration of diastole and circulation. Some drugs may cause vasospasm.
Sexual activity	Sexual activity increases the heart rate, stimulation of the sympathetic nervous system, and cardiac workload.

Stable angina pectoris

Stable angina pectoris is characterized by pain or tightness in the chest in response to exertion or stress with relief achieved within minutes by stopping or controlling the precipitating factor and taking nitrates. The symptoms may vary somewhat from one individual to another, but many describe a feeling of tightening, choking, or suffocating in the chest or heartburn-like symptoms with epigastric pain. Pain may initially be felt to the left of the sternum but usually moves centrally. Pain radiates most commonly to the left shoulder and arm although some people complain of radiating pain to the neck, right shoulder and arm, or back. Pain is rarely described as sharp or stabbing, descriptions more typical of myocardial infarction. Additionally, pain usually does not alter with change in breathing pattern or position. Accompanying symptoms may include shortness of breath, cold sweat, and weakness, especially in the arms.

The discomfort associated with stable angina usually recedes within about 3 minutes if precipitated by exertion but may last as long as 20 minutes if precipitated by stress, such as a very large meal or strong emotions (anger, fear). Stable angina tends to be predictable so that precipitating factors can be identified and anticipated and medication (nitrates) timed to prevent symptoms. Stable angina rarely lasts more than 30 minutes; indeed, angina of longer duration usually indicates a progression to unstable angina. Angina variations include nocturnal angina, which occurs only during the night but is not related to whether the person is awake or asleep, and angina decubitus, which occurs only when the person is lying down and recedes when the person stands or sits.

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Treatment for stable angina	
Acute episodes	• Sublingual nitroglycerine (TNT) at onset and repeated at 3 to 5-minute intervals with call to 9-1-1 if no relief within 5 minutes. Dosage varies (0.3-0.6 mg). Buccal spray in a metered (0.4mg) dose is an alternative. • Stop/control precipitating factor.

Preventive measures	• Avoidance of precipitating factors/lifestyle modifications. • Nitroglycerine 5 minutes before precipitating factor (0.3-0.6 mg sl or 0.4 to 0.8 mg per buccal spray) OR isosorbide dinitrate 2.5-10 mg sl. • Long-acting nitrates, such as isosorbide dinitrate, sustained release nitroglycerine, nitroglycerine ointment, or nitroglycerine patches. Dosages vary according to individual needs. Side effects include headaches, hypotension, nausea, and light-headedness, and long-term nitrate therapy may lead to tolerance. • □-Blockers may be used as first-line therapy for chronic angina. • Platelet inhibiting agent (aspirin, 81-325 mg daily) is recommended for all patients with stable angina.

Unstable angina

Unstable angina (also referred to as crescendo or preinfarction angina) may occur as a worsening of stable angina or may be the presenting symptom of coronary artery disease. Unstable angina is unpredictable and may occur at rest as well as with exertion. Unstable angina may indicate deterioration of plaques, such as rupture that causes local vasoconstriction and thrombus formation, putting the person at risk of myocardial infarction. The person with previously stable angina may note a significant change in the pattern of angina, such as increased pain and frequency of angina episodes. The pain related to unstable angina is usually refractory to treatment with nitroglycerine.

Treatment for stable angina	
Acute episode	Immediate hospitalization is indicated to prevent myocardial infarction. Low-molecular-weight heparin (sc or IV) is treatment of choice to prevent infarction.
Preventive measures	Nitrates or □-adrenergic blockers are indicated, but calcium channel blockers may be added if the person is already on □adrenergic blockers or cannot tolerate them. Platelet inhibiting agent (aspirin, 81-325 mg daily) is recommended for all patients with unstable angina. Aspirin may be combined with clopidogrel (Plavix®) to decrease the chance of blood clots.

Prinzmetal's angina

Prinzmetal's angina is a rare variant form that results not from mechanical occlusion of the arteries by plaques but from vasospasm of a major coronary artery. Prinzmetal's angina most commonly occurs in

people with a history of migraine or Raynaud's phenomenon and is not precipitated by exertion although it can occur with or without coronary artery disease. Prinzmetal's angina may be associated with smoking or use of alcohol or illicit drugs. It may occur during REM sleep because of the increased myocardial consumption of oxygen, so episodes occurring between 12 midnight and early AM are common. Prinzmetal's angina is characterized by pain accompanied by transient ST elevation of ECG and is usually not diagnosed by standard angiography; however, provocation testing (with substances such as acetylcholine) may demonstrate an exaggerated spasm.

Treatment for Prinzmetal's angina	
Acute episodes	Nitroglycerine as for stable angina
Preventive measures	Long-acting nitroglycerine or calcium channel blockers.

How is angina diagnosed?

Standard laboratory tests are of little help in diagnosing angina although they may identify risk factors, such as elevated cholesterol levels. Resting ECG may show no abnormalities, especially with stable angina, but during an angina episode, the ECG may show changes, such as horizontal or downsloping ST segment depression, which reverses with disappearance of ischemia. Prinzmetal's angina, however, is characterized by ST elevation.

The usual initial test is an exercise ECG ("stress test") on a motorized treadmill or bicycle ergometer. The most common protocol is the Bruce protocol in which the treadmill speed and slope increase every 3 minutes until symptoms occur. Exercise ECG is contraindicated for those with pain at rest or with minimal activity because of the danger of infarction. Additionally, since the person may be administered nitroglycerine if chest pains occur, that person should not take sildenafil citrate (Viagra®) within 24 hours of the test because the combination of drugs may cause hypotension. Additionally, the person must refrain from smoking, eating, and drinking fluids containing alcohol or caffeine for 3 hours prior to the test. If the person is unable to do the exercise test, then a chemical stress test may be done. The chemical stress test uses an IV agent, such as dipyridamole,

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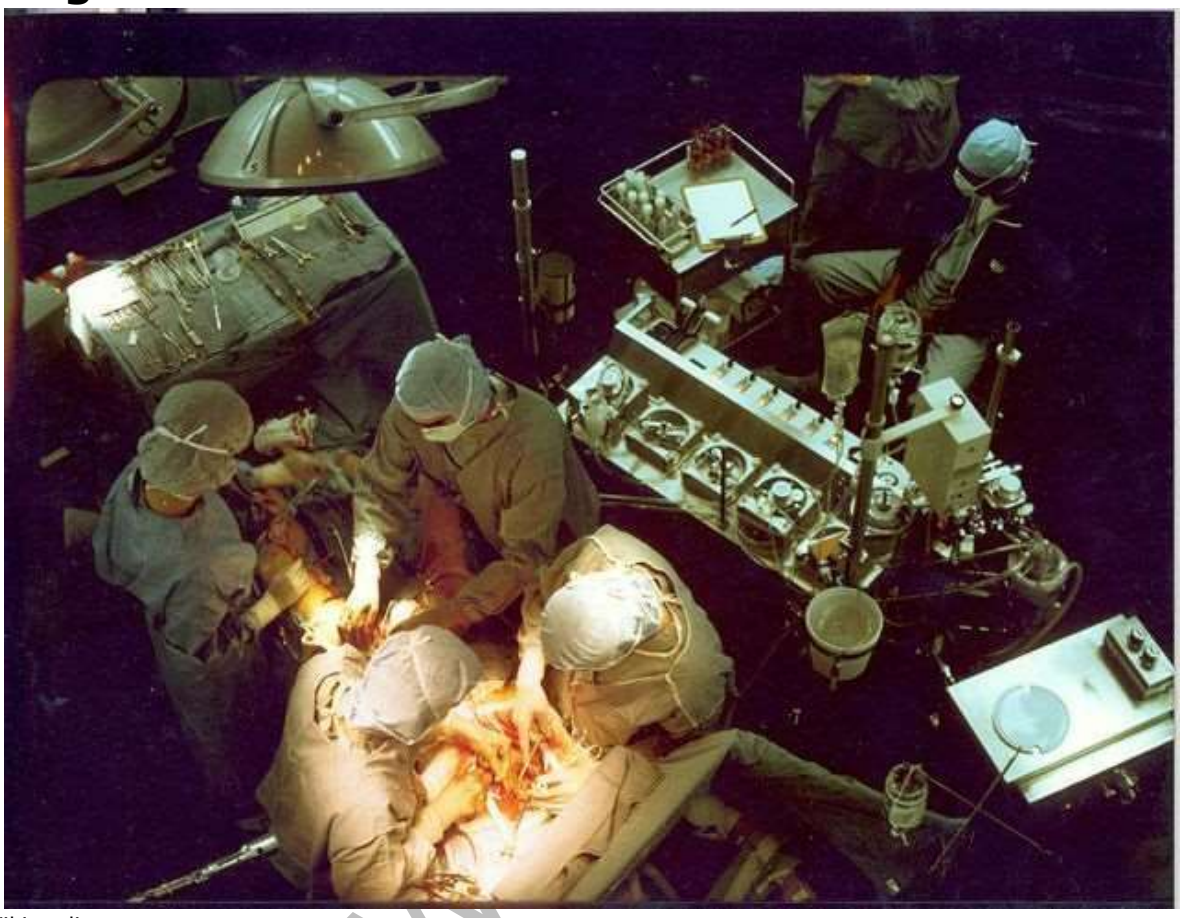
dobutamine, or adenosine to alter cardiac function rather than exercise.

Other diagnostic procedures can include myocardial perfusion scintigraphy, radionuclide angiography, stress echocardiography, CT scan to quantify coronary artery calcification, cardiac MRI, ambulatory ECG monitoring, and coronary angiography. Ambulatory ECG is sometimes used but may be of minimal value as it usually follows diagnosis based on symptoms and/or treadmill test.

Coronary angiography, which provides definitive diagnosis for coronary artery disease, is usually done if medical management of stable angina is not adequate, unstable angina is occuring, or other heart or valve disease is present or suspected. A catheter is usually inserted into the femoral area and fed to the heart where contrast medium is injected to provide contrast for radiographs. Narrowing of the lumen >50% is considered significant although many do not experience symptoms until the lumen has narrowed >70%.

PQRST method for questioning patients with chest pain/discomfort		
P	Precipitating events	What precipitated the pain/discomfort? • Exercise. • Eating. • Rest. • Stress, emotions (anger, fear, anxiety).
Q	Quality of pain/discomfort	What does it feel like? • Dull. • Sharp. • Aching. • Tight. • Suffocating.
R	Radiation of pain	Where is the pain located, and to where does it radiate? • Mid-chest, upper chest. • Neck. • Shoulders. • Arms. • Back.
S	Severity of pain	How would you rate the pain/discomfort on a scale of 1-10?
T	Timing	When did the pain/discomfort begin? How has it changed since then? Have you experienced similar pain/discomfort before?

Surgical treatments



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When occlusion of the coronary arteries poses an acute risk of myocardial infarction, surgical procedures may be considered. Surgery may also be used to provide relief of anginal pain that in uncontrolled by standard medications and limits the person's activities of daily living or quality of life. Surgery is often used to treat sudden onset of unstable angina and may be done as an emergency procedure.

Generally, surgery does not prolong life more than medical treatments for angina (especially if it is stable), so surgery is not the first line treatment but follows attempted control with medications. Risks of surgery increase with age. Those >79 have 3 times the risk of surgery-associated death as those 50 years old; however, surgery also has been shown to prolong life in older patients better than medical treatments alone, so each person must be evaluated individually and risks and benefits balanced.

Common percutaneous/surgical procedures

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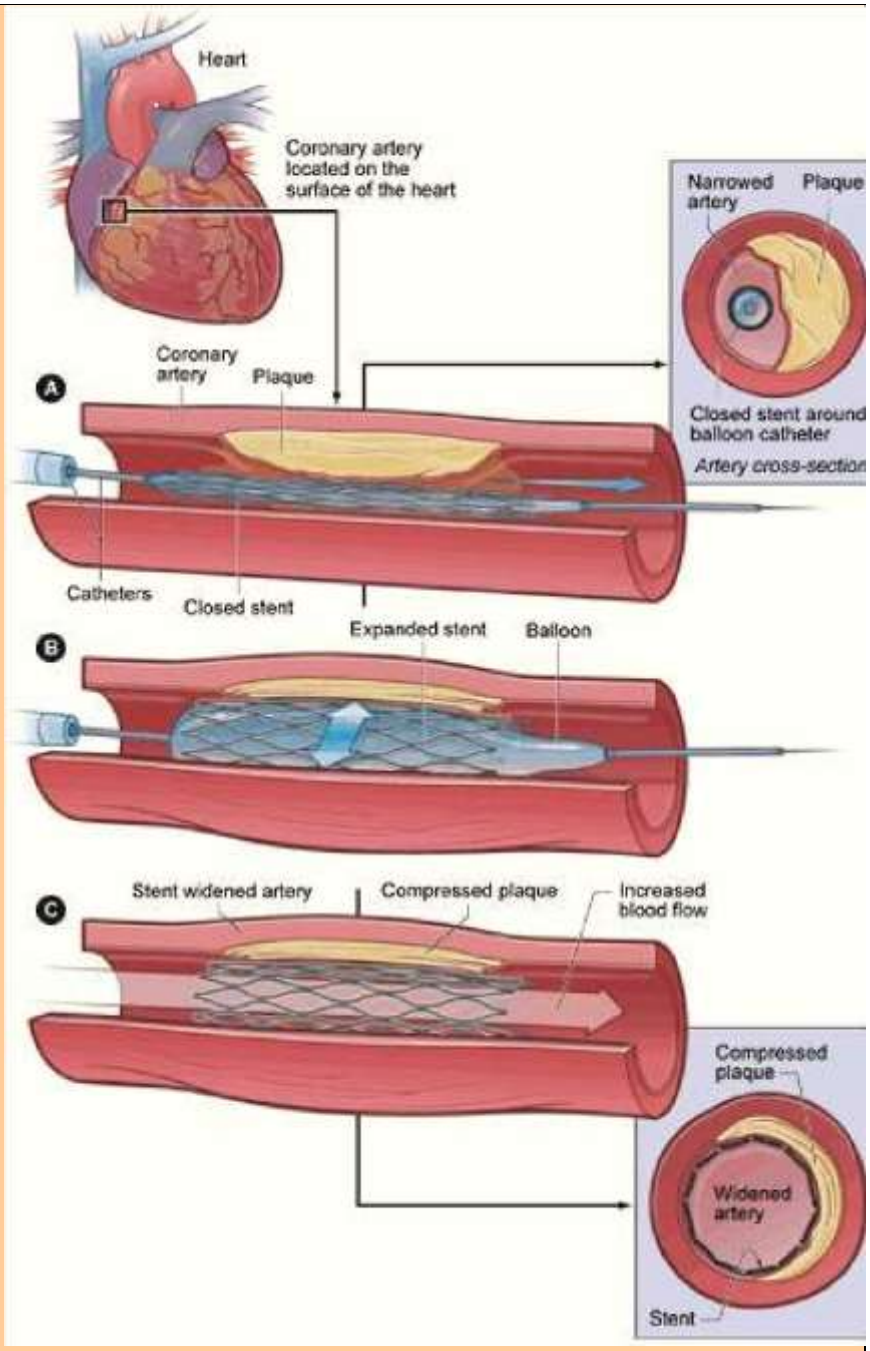
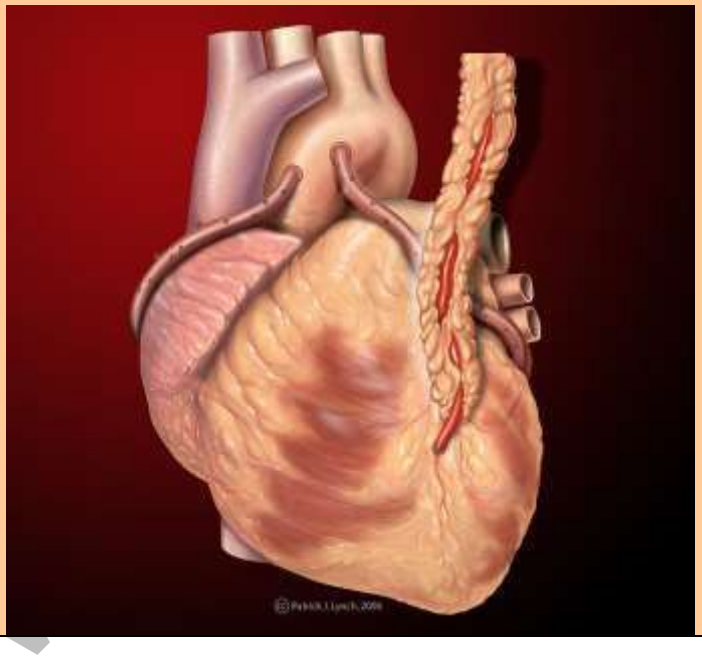
Percutaneous transluminal coronary angioplasty (PCTA) (with or without stent)	 NIH PCTA is done with a sheath inserted into the femoral vein or artery with fluoroscopy used to verify position of the atheroma. A balloon-tipped catheter is fed to the site and the balloon inflated to compress the plaque until residual stenosis is <20%. Laser may also be used to vaporize plaque. Stents of plastic or wire mesh are usually inserted to maintain patency.

Coronary artery bypass grafting (CABG)	CABG is indicated for treatment of angina that does not respond to medical treatment and unstable angina with blockage of >60% in left main coronary artery or blockage of multiple coronary arteries. The surgery requires cardiopulmonary bypass and a midsternal incision. Bypass grafts are sutured into place from the aorta to the myocardium. Grafts can be obtained from various sites, but the internal mammary artery is 

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	commonly used for elective procedures and saphenous vein for emergency procedures.
Minimallyinvasive direct coronary artery bypass (MIDCAB)	This procedure is completed on the beating heart and does not utilize cardiopulmonary bypass. The incision is in the mid-chest, over the bypass area, after removal of a portion of a rib. This procedure, which uses the internal mammary artery, is only suitable for bypasses for one or two coronary arteries.
Directional coronary atherectomy (DCA)	This procedure may be done instead of angioplasty or as a second step in angioplasty if the lumen is very narrow. The procedure is similar except that a window opens on one side of the balloon with a rotational cutting piston inside that shaves away the atheroma, pushing the residue of the plaque inside the catheter.

Rotational atherectomy (ROTA)	ROTA is similar to DCA except the end of the catheter contains a diamond chip drill to remove plaque debris.
Transluminal	Similar to ROTA, this procedure uses a motorized
extraction	cutting head but also contains a vacuum device to remove plaque debris.
Transmyocardial laser revascularization (TMR)	TMR may be done percutaneously or through a surgical incision. Percutaneously a fiberoptic cable is threaded into the left ventricle against an ischemic area and carbon dioxide laser bursts cut 20 to 40 one-millimeter channels into the myocardium to stimulate an inflammatory response and development of new vessels. Surgically, the laser cuts are made on the outside of the left ventricle while cardiopulmonary bypass is in place.

Summary

Angina results from ischemia or lack of adequate oxygen to the heart muscle. The most common cause of angina is atherosclerosis, but it may also result from other conditions that impair blood flow. Precipitating factors include exercise, temperature extremes, emotional changes, smoking, stimulant drugs, and sexual activity. Stable angina pectoris is characterized by pain or pressure in the chest in response to exertion or stress with relief within minutes by stopping precipitating factor. Stable angina usually responds well to medications, such as nitroglycerine, but may progress to unstable angina over time. Unstable angina is much less predictable ans is a medical emergency as it may be a precursor to a myocardial infarction. It is less responsive to medications and may require surgical intervention. Prinzmetal's angina is caused by vasospasm rather than occluded arteries and may be associated with smoking and drug use. Angina is most commonly diagnosed by stress testing. If angina is not responsive to medical treatment, then percutaneous or surgical procedures may be indicated. Interventions include PCTA (with or without stent), CABG, MIDCAB, DCA, ROTA, transluminal extraction, and transmyocardial laser revascularization (TMR).

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