



Patient education: Coronary artery bypass graft surgery (Beyond the Basics)

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BYPASS SURGERY OVERVIEW

The coronary arteries of people with coronary heart disease become clogged with calcium and fatty deposits. The deposits, called plaques, narrow the arteries that carry blood to the heart muscle ([figure 1](#)). Blood supplies the heart muscle with oxygen and sources of energy; ischemia (a reduction in blood flow and oxygen) can produce symptoms of pain in the chest (angina pectoris). In more severe cases, heart attack (myocardial infarction), heart failure, or rhythm abnormalities can cause sudden cardiac death.

Coronary artery bypass graft surgery, or CABG (pronounced "cabbage"), is a procedure that uses your own veins (usually from the legs) or arteries (usually from the chest or arm) to bypass narrowed areas and restore blood flow to heart muscle. Thus, bypass surgery can markedly reduce or relieve chest pain for most people, and can prolong life for those with certain patterns of severe coronary heart disease.

The final decision regarding the best choice of treatment depends upon several factors, including the benefit versus risk of surgery, the severity of your symptoms and cardiac disease, and your underlying medical problems. You should discuss the details of your case with your healthcare provider. (See "[Patient education: Angina treatment — medical versus interventional therapy \(Beyond the Basics\)](#)".)

IS BYPASS SURGERY RIGHT FOR ME?

Surgical treatment may be recommended for different situations:

Stable angina — Angina (chest pain) is considered stable when its frequency, severity, duration, and precipitating factors are not changing. There are several treatment options for people with stable angina. These options are classified as medical therapy (medications) and interventional treatment (procedures to open or bypass narrowed coronary arteries). Coronary artery bypass graft surgery (CABG) is one form of interventional treatment. People with stable angina may require CABG if they have persistent and intolerable symptoms despite optimal medical treatment, specific patterns of arterial narrowing in several vessels, or high risk of heart attack and death.

Another interventional treatment option for people with coronary heart disease is called "percutaneous coronary intervention" (PCI) or "stenting." In the past, it has been referred to as "angioplasty." This involves using a flexible plastic catheter with a tiny balloon at the end to dilate narrowed arteries in the heart; a metal device (stent) is then placed at the site of the blockage to help prevent re-narrowing (called restenosis). This procedure is less invasive than CABG. Stenting is discussed in more detail elsewhere. (See "[Patient education: Stenting for the heart \(Beyond the Basics\)](#)".)

Extensive disease — People with extensive coronary heart disease, including narrowing of the left main coronary artery, multiple narrowed coronary arteries, and poor pumping function of their left ventricle (lower heart chamber), generally live longer when they undergo CABG as compared with people who have medical therapy or PCI. For some people with blockages in more than one artery, physicians might recommend using both CABG and PCI in order to achieve the best result.

Future risk of cardiac event — Some people are identified as having a high risk for a future cardiac event based on a stress test (which measures how well the heart works when it is beating faster, such as during exercise). The test may show changes in the electrocardiogram (called ECG or EKG), poor exercise capacity, failure to raise blood pressure during exercise, or severely limited blood flow to multiple areas of the heart. Imaging with a test called a myocardial perfusion scan or echocardiogram may be obtained immediately after exercise to determine the degree and amount and location of ischemia (decreased oxygen supply).

Unstable angina — People who develop unstable angina may be candidates for CABG or stenting. Angina is considered unstable if it becomes more frequent, occurs with less exertion or at rest, is more severe, lasts longer, or fails to respond to appropriate medication.

After myocardial infarction — During unstable angina or an acute myocardial infarction, PCI is highly successful and is the preferred management. People who have acute MI complications such as a leaky heart valve, cardiogenic shock requiring mechanical support, or a coronary anatomy that is unfavorable or not feasible with PCI may undergo CABG.

BYPASS SURGERY PROCEDURE

With coronary artery bypass graft (CABG) surgery, a leg vein or an artery taken from the chest or arm is grafted from the aorta (the major blood vessel exiting the heart) onto the coronary artery, beyond the narrowed segment ([figure 2](#)). This bypasses the diseased section and restores blood flow to the area of the heart muscle supplied by that artery. Often, more than one graft is placed.

Choice of graft — Generally, blood vessels can be obtained from four areas of the body: the chest, leg, arm, and abdomen.

- Internal thoracic arteries (also called internal mammary arteries) are under the left and right sides of the breast bone. Unlike vein or radial artery grafts (described below), internal thoracic grafts are not fully removed from their original position. These grafts remain connected to their natural site of origin, and only the distal end is separated from the chest wall. This end is then attached to one of the coronary arteries. The left internal thoracic artery (also known as the left internal mammary artery or LIMA), which runs close to the most important coronary artery (the anterior descending coronary artery, or LAD), is generally the first choice for a graft, as it has been shown to improve outcomes.

In general, arterial grafts rarely develop stenosis (narrowing) and have an improved long-term patency compared with vein grafts. In addition, people with arterial grafts tend to have better survival, fewer reoperations, a lower rate of myocardial infarction, and less recurrent angina, as compared with vein grafts.

- Radial arteries are taken from the inner forearm. The long-term outcome with these arteries is also excellent and almost equivalent to that of the internal thoracic artery. There are usually only minimal changes in hand function after removal of the radial artery for CABG, which manifest as a small amount of forearm numbness and tingling, but generally no change in motor function or tolerance to temperature or pain. In the majority of these people, the symptoms are self-limited.
- Saphenous veins are taken from the leg (calf or thigh). Narrowing (stenosis) of the vein graft due to changes that are similar to those of a coronary artery is a major problem with saphenous vein grafts. These narrowings develop in approximately 50 percent of people. Some narrowings occur as early as months after surgery, while others develop within five to seven years. A number of factors may predispose to saphenous vein graft disease if not well controlled, including lack of regular exercise, smoking, hypertension, lipid abnormalities, and diabetes.

The surgery — Conventional CABG is performed while the person is under general anesthesia (completely asleep with medication). The surgery generally takes three to six hours. The surgeon divides the breastbone (sternum), called a median sternotomy, to open the chest and gain access to the heart. If the internal mammary artery is being used, it is separated from the chest wall; if a vein or radial artery is being used, it is removed from the leg or arm.

Attaching the bypass vessel to the coronary artery requires the heart to be temporarily stopped using chemicals and cold (hypothermia) so that the surgeon can sew on the grafts.

While the heart is stopped, blood circulation is maintained with a heart-lung machine, or cardiopulmonary bypass machine. This functions like the heart and lungs, circulating blood and providing oxygen to the body. Fluids, nutrients, and medications may be added to the blood while it passes through the cardiopulmonary bypass machine.

The surgeon sews one end of the graft onto the aorta and the other end to a part of the coronary artery beyond the narrowing, hence bypassing the diseased area.

Other procedures — Several new surgical approaches are now being developed that may reduce the discomforts and risks associated with traditional bypass surgery. Known as "minimally invasive bypass surgery" and "off-pump surgery," these approaches use a small chest incision and are performed on the heart while it is still beating. These techniques have become increasingly popular but are not appropriate for all bypass situations. In the hands of surgeons with wide experience using this technique, long-term outcomes are comparable to the standard CABG operation and generally involve a shorter stay in the hospital.

BYPASS SURGERY RISK

There are a number of health factors that contribute to the risk of CABG, including other disease (advanced kidney, pulmonary, cerebral vascular disease, etc), advanced age, marked obesity, poorly controlled diabetes or hypertension, and frailty. The latter is a measure of overall patient health status. Patients with a high frailty score have a higher operative risk and a more favorable outcome with nonsurgical treatment.

BYPASS SURGERY RECOVERY

Immediately after surgery, the person spends one to two days in an intensive care unit. Family members can visit periodically during this time. A number of systems are used to monitor the person's heart rate and rhythm, blood pressure, temperature, and breathing rate; monitoring is gradually discontinued as the person recovers.

- The breathing tube that was placed in the airway before surgery is removed as soon as the person is awake and able to breathe on their own. Most people awaken within a few hours after surgery. It is common to feel groggy and disoriented during this time.
- A thin, flexible tube (catheter) is usually placed in the bladder before surgery begins. The catheter is needed to collect and measure urine. Once the person is able to get up and go to the bathroom, the catheter is removed.
- Fluids, medications, and sometimes blood transfusions are given before, during, and after the surgery through an intravenous (IV) line. When the person is able to eat and drink and no longer requires IV medications, the line is removed.
- Tubes are placed inside the chest to drain fluids that accumulate in the chest and around the heart after surgery. These are usually removed within one to three days after surgery.
- The incision in the chest is usually sore, with the most discomfort in the first 48 to 72 hours after surgery. Pain medications are usually given to relieve discomfort.

When continuous monitoring is no longer required, usually after 12 to 24 hours, most people are moved to a step-down or transitional care unit. Most people can sit in a chair the day after surgery. The person is encouraged to start walking within one to two days after surgery.

- Many people have a poor appetite for several weeks after surgery. This is normal and expected. Talk to a doctor or nurse if there are concerns about appetite.
- Constipation is also common during this time, due to decreased activity and food intake and use of pain medications. Medications to relieve constipation may be recommended. (See "[Patient education: Constipation in adults \(Beyond the Basics\)](#)".)
- People who have a graft harvested from the leg sometimes notice swelling in this leg after surgery. Elevating the leg and wearing compression stockings can help to reduce swelling.
- It is common to have difficulty sleeping after bypass surgery, especially while in the hospital. This usually improves after discharge from the hospital.
- Depression, to at least a mild degree, occurs in approximately 20 to 40 percent of people after CABG. Generally, this resolves within a few weeks without requiring intervention. Signs of depression include sadness for most of the day, diminished pleasure or interest in almost all activities, insomnia or excessive sleep, or feelings of worthlessness or guilt. Depression can interfere with recovery and increase the risk of heart problems in the future. Anyone who notes signs of depression that last for more

than two weeks should speak to their healthcare provider about treatment options. (See "[Patient education: Depression in adults \(Beyond the Basics\)](#)".)

Most people recover in the hospital for four to five days after surgery. However, hospitalization may be longer, depending upon an individual's rate of recovery and any complications that develop.

People who do not have complications or a prolonged hospital stay are usually able to return to desk work within four to six weeks. The split sternum will require about six weeks for complete healing; during this time period, heavy lifting must be avoided. People who have a physically demanding job often need more time to recover. Complete recovery from surgery often takes two to three months. Care at home after surgery is discussed in a separate topic review. (See "[Patient education: Recovery after coronary artery bypass graft surgery \(CABG\) \(Beyond the Basics\)](#)".).

BYPASS SURGERY COMPLICATIONS

Although uncommon, there are a number of complications that can occur after coronary artery bypass graft surgery (CABG). The major complications include bleeding that may require a return to the operating room, heart attack, heart failure, arrhythmia, stroke, changes in cognitive function, pulmonary problems, wound infection, renal failure, and death.

Postoperative complications may be related to the body's response to artificial blood circulation and gas exchange through the cardiopulmonary bypass apparatus.

Cardiac complications — Many complications affect the heart directly.

- Two to 4 percent of people experience electrocardiographic or enzyme evidence of a heart attack after surgery. This occurs less frequently in people who are low risk as compared with those who are high risk. People at high risk include those who are undergoing urgent or repeat CABG, are in shock or require mechanical support prior to surgery, or need CABG combined with other cardiac surgery. Generally, postoperative heart attacks are small to moderate in size.
- Especially in people with some damage to the heart muscle prior to CABG, low cardiac output (when a reduced volume of blood is pumped out of the heart to the body) can occur during or after surgery. This is often temporary and responds to intravenous fluids and/or a brief period of therapy to improve heart function. Therapy may include medications or a special mechanical device that can augment the heart's ability to contract (intraaortic balloon pump or left ventricular assist device).

- Tachyarrhythmias (temporary rapid, and/or irregular heart rhythms) may occur after CABG.

Atrial fibrillation, an abnormal rhythm of the heart, occurs in up to 40 percent of cases but can be controlled with medications. This rhythm disturbance may cause a blood clot to develop within the heart. If this blood clot becomes dislodged, it can travel to another organ in the body, such as the brain, resulting in a stroke. Atrial fibrillation after CABG is usually temporary; if persistent, longer-term treatment may be required. (See "[Patient education: Atrial fibrillation \(Beyond the Basics\)](#)".)

Sustained ventricular tachycardia (a rapid and regular heart beat) or ventricular fibrillation (a rapid, chaotic, and ineffective heart beat) occurs in approximately 2 to 3 percent of people, usually within four days of surgery. An automatic internal defibrillator may be needed for selected people in whom this is judged to be a persistent rather than a transient risk. (See "[Patient education: Implantable cardioverter-defibrillators \(Beyond the Basics\)](#)".)

Postoperative bradyarrhythmias cause the heart to beat too slowly and require placement of a permanent pacemaker in 0.8 to 4 percent of people. (See "[Patient education: Pacemakers \(Beyond the Basics\)](#)".)

- Pericarditis is an inflammation of the pericardium, the sac that surrounds the heart. Sometimes pericarditis is accompanied by pericardial effusion, in which the pericardial sac fills up with fluid. If a large amount of fluid accumulates in the pericardium, it may squeeze or constrict the heart, called cardiac tamponade. In that case, the fluid can generally be removed with a needle and if recurrent, it will be treated with medication or a small procedure on the pericardium that allows for long-term drainage.

Pericarditis often causes chest pain, which generally occurs a few days to several weeks after surgery. Pericardial effusions are usually small and resolve without treatment. If the effusion is large, urgent treatment or reoperation may be needed.

Bleeding — Approximately 30 percent of people require a blood transfusion after CABG. People with heavy bleeding that requires reoperation often need multiple blood transfusions and stay longer in the intensive care unit and hospital. Only about 2 percent of people require surgery to stop excessive bleeding.

Some medications significantly increase the risk of postoperative bleeding. [Clopidogrel](#) (brand name: Plavix), [prasugrel](#) (brand name: Effient), [ticagrelor](#) (brand name: Brilinta), and [ibuprofen](#) are generally discontinued for several days prior to coronary surgery. People taking [warfarin](#) (brand name: Coumadin or Jantoven), [apixaban](#) (brand name: Eliquis), [rivaroxaban](#) (brand name: Xarelto), [edoxaban](#) (brand name: Savaysa), or [dabigatran](#) (brand name: Pradaxa) should speak with their surgeon about how and when to stop it before surgery and when to resume after CABG. The risk of bleeding is mildly increased with [aspirin](#),

but in many cases, doctors continue it up to surgery. (See "[Patient education: Warfarin \(Beyond the Basics\)](#)".)

Neurologic complications — Neurologic complications include stroke, postoperative delirium, short- and long-term cognitive changes, and depression. The incidence of neurologic problems following CABG is approximately 2 to 4 percent; older people and women are affected more frequently.

Infection — The surgical sites involved in CABG can become infected after the surgery.

Sternal wound — Infection of the chest incision (called the sternal wound) occurs in approximately 1 percent of people. It usually develops by seven to nine days after surgery. Diabetes mellitus, obesity, and the use of both left and right internal mammary arteries increase the risk of sternal wound infection. Women with a history of breast cancer are at especially high risk, possibly related to therapies used during breast cancer treatment.

Leg wounds — Leg wounds develop complications after saphenous vein graft harvesting in approximately 5 percent of people. The most common complications include dermatitis (inflammation of the skin), cellulitis (a bacterial infection of the skin), nerve damage, and non-healing ulcers; most are minor and do not require surgical intervention.

Renal failure — A temporary decrease in kidney function occurs in approximately 5 to 10 percent of people undergoing CABG. Very uncommonly, a person may need temporary dialysis (treatment to remove waste from the blood periodically while the kidneys are unable to do this).

Other complications — A number of other complications may occur as well.

- **Pleural effusions** – Pleural effusions are collections of fluid in the membranes surrounding the lungs. These are common after CABG, occurring in up to 90 percent of people. They are usually small and do not require treatment.
- **Phrenic nerve damage** – The phrenic nerve, the nerve that controls the diaphragm, is damaged during CABG in less than 1 percent of people. Damage can cause diaphragm dysfunction or paralysis. Most people recover fully within one year.
- **Intercostal nerve damage** – The intercostal nerves are connected to the thorax and abdomen. Harvesting the internal mammary artery can injure these nerves. Symptoms of nerve damage include numbness, tenderness, or burning discomfort over the sternum and left anterolateral chest wall. Pain usually subsides by four months.
- **Aortic dissection** – Aortic dissection, a disorder in which the layers of tissue that make up the aorta split apart, can occur after CABG. People who are older or have

longstanding high blood pressure, severely narrowed coronary arteries, or widening of the aorta are at greater risk.

- Thrombocytopenia – Heparin is given during CABG to prevent the blood from clotting during and after the procedure. In some cases, heparin can cause a temporary decrease in the number of platelets in the blood (called thrombocytopenia), which can decrease clotting ability and increase the risk of bleeding. If needed, other medications may be used to induce anticoagulation without producing thrombocytopenia.

LONG-TERM OUTCOME

As mentioned above, people with symptomatic angina who undergo coronary artery bypass graft surgery (CABG) can have greatly improved outcomes.

There are a number of factors that influence the long-term outcome after CABG. One of these is how patent, or open, the graft remains over time. If the grafts do not remain open, stent placement or another operation may be needed. The choice of graft, as discussed above, can greatly influence the need for reoperation.

Angina after surgery — About 95 percent of people who have narrowing of several arteries have improvement or complete relief of their angina immediately after surgery. About 85 to 90 percent of people remain angina-free at one to three years after surgery, and about 75 percent of people remain angina-free or free of major coronary events at five years after surgery.

Reasons for recurrence of angina include

- Narrowing that develops in the graft used for the bypass
- Progression of disease in the bypassed or non-bypassed vessels

The recurrence of angina is less frequently seen when the vessel used for the bypass is an artery as compared to a vein. By 10 years, 90 percent of arterial grafts are still open; in contrast, about one-half of all vein grafts become narrowed or occluded at 10 years after bypass surgery, and by 15 years, about 85 percent of vein grafts become narrowed or occluded. These late events, which are often associated with recurrence of symptoms, usually require a second revascularization procedure, most often done with stent placement, and less often with a repeat surgical bypass, since repeat surgical bypass is associated with a higher risk than the initial CABG.

CARE AFTER BYPASS SURGERY

Cardiac recovery and care is discussed in detail in a separate topic review. (See "[Patient education: Recovery after coronary artery bypass graft surgery \(CABG\) \(Beyond the Basics\)](#)".)

WHERE TO GET MORE INFORMATION

Your healthcare provider is the best source of information for questions and concerns related to your medical problem.

This article will be updated as needed on our web site (www.uptodate.com/patients). Related topics for patients, as well as selected articles written for healthcare professionals, are also available. Some of the most relevant are listed below.

Patient level information — UpToDate offers two types of patient education materials.

The Basics — The Basics patient education pieces answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials.

[Patient education: Coronary artery disease \(The Basics\)](#)

[Patient education: Coronary artery bypass graft surgery \(The Basics\)](#)

[Patient education: Heart attack \(The Basics\)](#)

[Patient education: Medicines after a heart attack \(The Basics\)](#)

[Patient education: Cardiac tamponade \(The Basics\)](#)

[Patient education: How to protect the chest after heart surgery \(The Basics\)](#)

Beyond the Basics — Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are best for patients who want in-depth information and are comfortable with some medical jargon.

[Patient education: Angina treatment — medical versus interventional therapy \(Beyond the Basics\)](#)

[Patient education: Constipation in adults \(Beyond the Basics\)](#)

[Patient education: Depression in adults \(Beyond the Basics\)](#)

[Patient education: Recovery after coronary artery bypass graft surgery \(CABG\) \(Beyond the Basics\)](#)

[Patient education: Atrial fibrillation \(Beyond the Basics\)](#)

[Patient education: Implantable cardioverter-defibrillators \(Beyond the Basics\)](#)

[Patient education: Pacemakers \(Beyond the Basics\)](#)

[Patient education: Warfarin \(Beyond the Basics\)](#)

Professional level information — Professional level articles are designed to keep doctors and other health professionals up-to-date on the latest medical findings. These articles are

thorough, long, and complex, and they contain multiple references to the research on which they are based. Professional level articles are best for people who are comfortable with a lot of medical terminology and who want to read the same materials their doctors are reading.

Revascularization in patients with stable coronary artery disease: Coronary artery bypass graft surgery versus percutaneous coronary intervention

Coronary artery bypass grafting in patients with cerebrovascular disease

Early cardiac complications of coronary artery bypass graft surgery

Early noncardiac complications of coronary artery bypass graft surgery

Coronary artery bypass graft surgery: Graft choices

Chronic coronary syndrome: Indications for revascularization

Minimally invasive aortic and mitral valve surgery

Off-pump and minimally invasive direct coronary artery bypass graft surgery: Clinical use

Neurologic complications of cardiac surgery

Postoperative mediastinitis after cardiac surgery

The following organizations also provide reliable health information.

- National Library of Medicine

(www.nlm.nih.gov/medlineplus/healthtopics.html)

- National Heart, Lung, and Blood Institute

(www.nhlbi.nih.gov/)

- American Heart Association

(www.americanheart.org)

- Society of Thoracic Surgeons

(www.sts.org)

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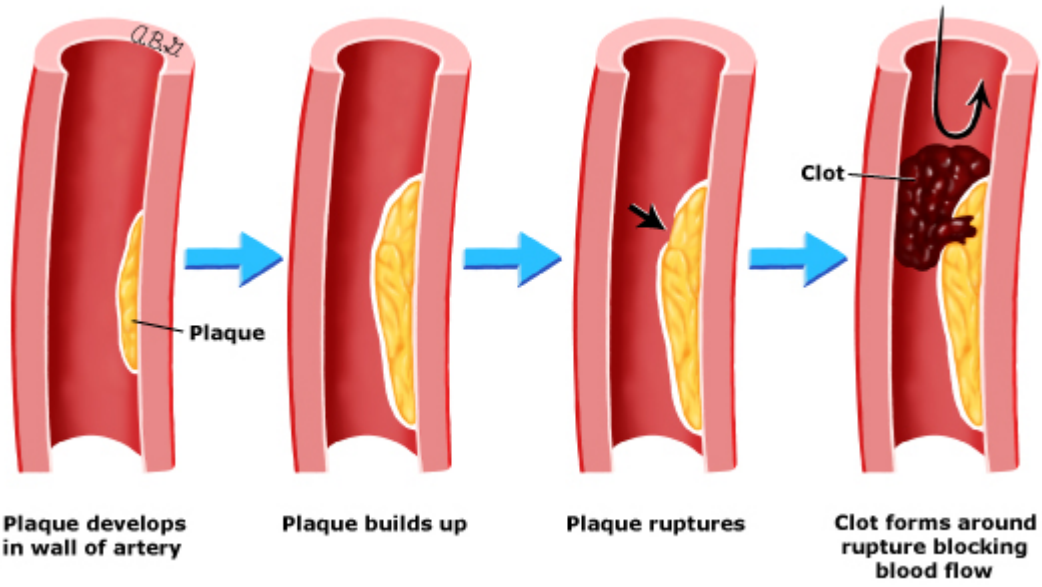
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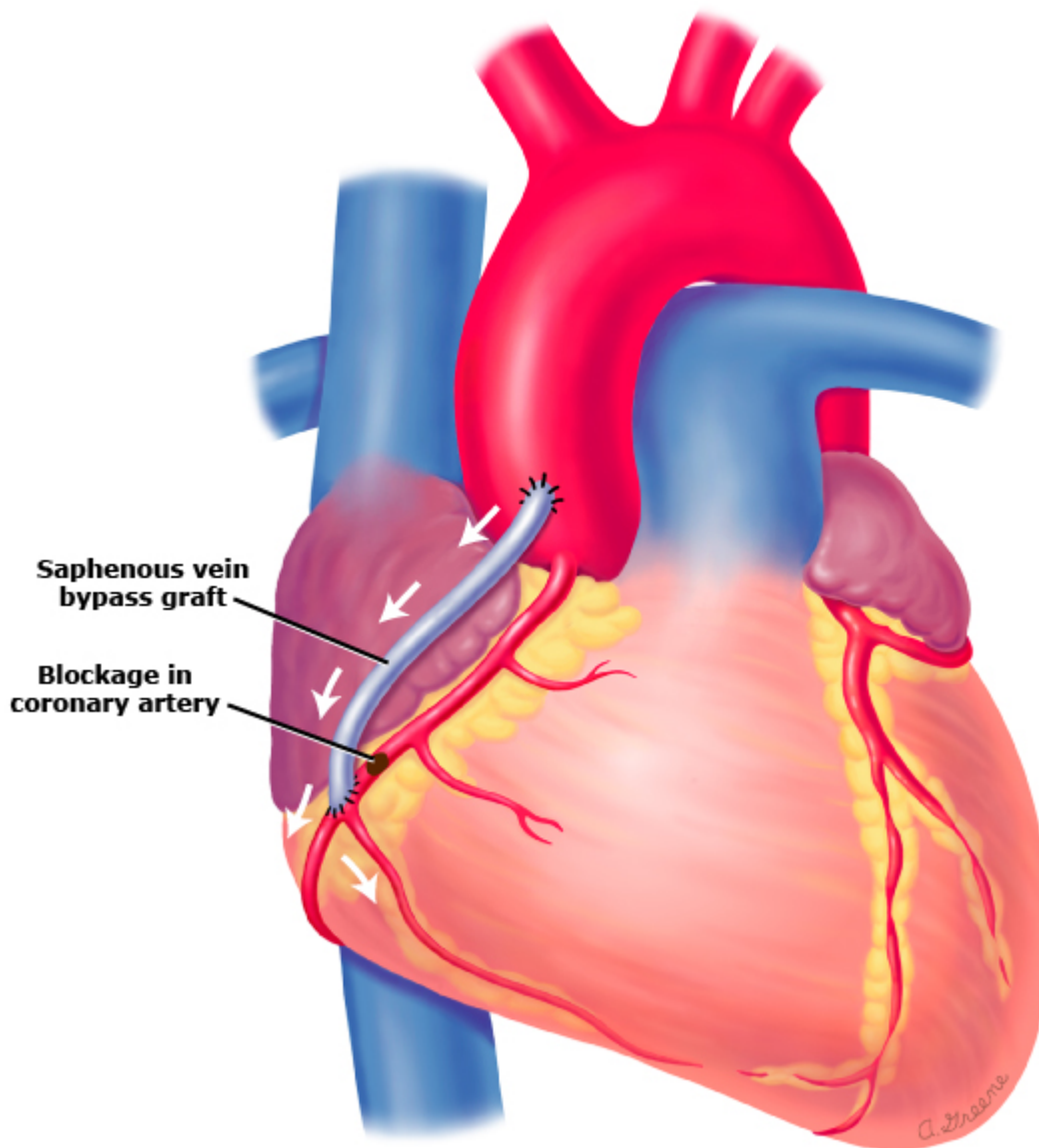
GRAPHICS

Plaque formation



Graphic 78702 Version 3.0

Coronary artery bypass graft surgery



During coronary artery bypass surgery, the surgeon removes a piece of blood vessel from the leg, chest, arm, or belly. Then, they use that piece of blood vessel (called a "graft") to reroute blood around the blocked artery. This is called "bypass surgery" because it bypasses the blockage. Some people have more than 1 blocked artery bypassed. In this picture, the graft came from a vein in the leg called the "saphenous vein." But grafts can come from other places, too.

Graphic 73589 Version 7.0

