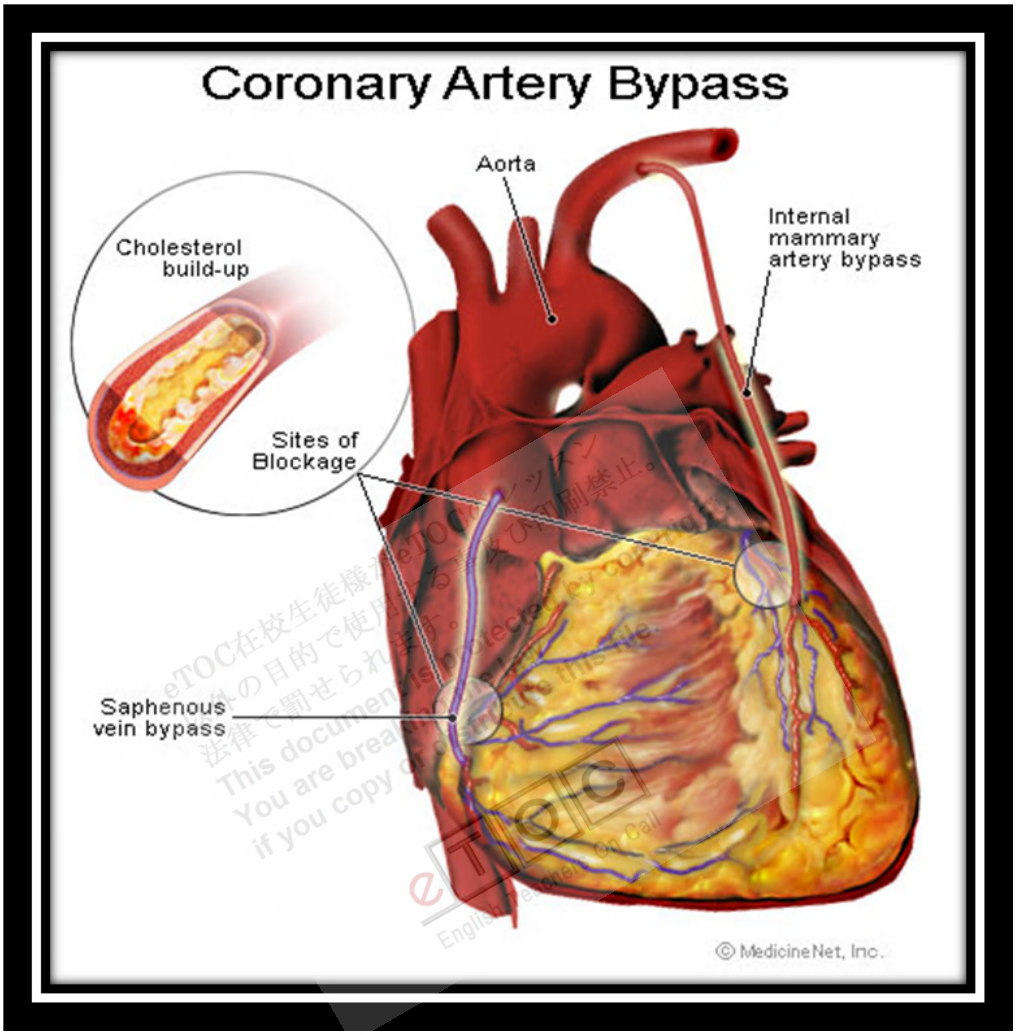
Coronary Artery Bypass Grafting (CABG)



http://intensivecare.hsnet.nsw.gov.au/five/images/coronary_artery_bypass.jpg

Coronary artery bypass grafting involves bypassing native coronary arteries with high-grade stenosis or occlusion not amenable to angioplasty with stent insertion. Indications are changing as percutaneous interventions are being increasingly used.

Traditional CABG Procedure

The procedure involves **thoracotomy** via a midline (median) **sternotomy**. A heart-lung machine is used to establish cardiopulmonary bypass (CPB), allowing the heart to be stopped and emptied of blood to maximize operative exposure and facilitate vessel **anastomosis**; stopping the heart also markedly decreases myocardial O_2 demand. Before initiation of CPB, the patient is given a very high dose of heparin to prevent

clotting in the bypass circuit. Then the aorta is cross-clamped and the heart is stopped by injection of a **cardioplegic solution** (crystalloid or more commonly blood-based) that also contains substances that help myocardial cells tolerate ischemia and **reperfusion**. The cardioplegic solution and the heart are sometimes cooled slightly to enhance tolerance of ischemia; the patient's body is cooled via the CPB machine for similar reasons.

The left internal mammary artery is typically used as **a pedicled graft** to the left anterior descending coronary artery. Other grafts consist of segments of **saphenous vein** removed from the leg. Occasionally, the right internal mammary artery or radial artery from the nondominant arm can be used.

On completion of the vascular anastomoses, the aorta is **unclamped**, allowing the coronary arteries to be perfused by oxygenated blood, which typically restores cardiac activity.Heparin anticoagulation is reversed by giving protamine. Despite cardioprotective measures, stopping the heart is not without consequences. During reperfusion, myocardial dysfunction is common and can lead to bradycardia, arrhythmias (eg, ventricular fibrillation), and low cardiac output; these events are treated by standard measures, such as pacing, **defibrillation**, and **inotropic drugs**.

Typically, hospital stays are 4 to 5 days unless prolonged by complications.

Complications: Complications and disadvantages of traditional CABG involve mainly

- **Sternotomy**
- CPB

Median sternotomy is surprisingly well tolerated; however, healing takes 4 to 6 wk. Also, wound infections occasionally cause **mediastinitis** or sternal **osteomyelitis**, which can be **vexing** to treat.

CPB causes several complications, including

- Bleeding
- Organ dysfunction
- Neuropsychiatric effects
- Stroke

Post-CPB bleeding is a common problem caused by various factors, including hemodilution,heparin use, platelet dysfunction due to exposure to the bypass pump, consumptive coagulopathy, and induced hypothermia. Also, the CPB machine evokes a

systemic inflammatory response (probably due to exposure of blood components to the foreign material of the bypass circuit); this response can cause organ dysfunction in any system (eg, pulmonary, renal, brain, GI). **Aortic cannulation**, cross-clamping, and release can trigger release of emboli, causing stroke in about 1.5%; microemboli may contribute to post-CPB neuropsychiatric effects, which appear in about 5 to 10%.

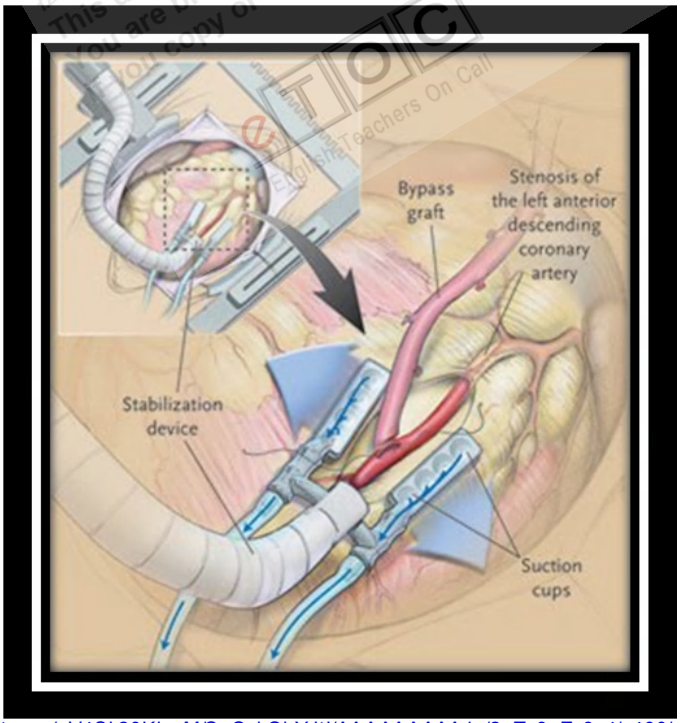
Other common complications of CABG include focal and global myocardial ischemia and dysrhythmias. **Perioperative MI** occurs in about 1% of patients. **Atrial fibrillation** occurs in 15 to 40% of patients, typically 2 to 4 days after surgery. Nonsustained ventricular tachycardia may occur in up to 50% of patients.

Mortality depends mainly on patients' underlying health; operator and institutional experience (ie, number of annual procedures) also is important. In an experienced program, periprocedural mortality in otherwise healthy patients is typically < 1 to 3%.

Alternative CABG Procedures

Newer techniques seek to limit the complications of traditional CABG by

- Avoiding CPB (off-pump CABG)
- Avoiding median sternotomy (minimally invasive CABG)
- Both



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CPB can be avoided in select patients by using new techniques that allow the surgeon to **revascularize** the beating heart. Various devices and methods stabilize a portion of the myocardium, holding the operative site relatively motionless. Off-pump procedures are more commonly done through small parasternal or **intercostal incisions** (minimally invasive CABG), sometimes with endoscopy or even robotic assistance, but they may be done through a traditional median sternotomy, which provides better operative exposure.

Allowing the heart to beat means that the myocardium requires more O_2 than when CPB is used. Thus, the heart is sensitive to the interruption of blood flow necessitated while the vascular anastomosis is done; this interruption can cause ischemia or infarction in the myocardium supplied by the affected vessel. Some surgeons place a temporary coronary artery shunt to provide distal perfusion.

The minimally invasive technique is somewhat more difficult to do and may not be suitable when multiple bypass grafts, particularly those involving vessels behind the heart, are required. Transfusion requirements, length of stay, and costs are typically less with off-pump CABG, but in some studies, the rate of the more serious complications of death, MI, and stroke are similar to that of CABG using CPB. Thus, the theoretic advantages of avoiding CPB do not seem to have been fully realized.

Minimally invasive CABG is usually done off-pump but may be done using CPB. In such cases, CPB is done endovascularly using special catheters inserted into the arterial and venous systems; the aorta is occluded by a balloon at the end of the aortic catheter rather than an external clamp. Although avoiding median sternotomy complications, this technique otherwise has similar rates of mortality and major perioperative complications as conventional techniques.

Reference: http://www.merckmanuals.com