# Clinical Outcomes of Coronary Artery Bypass Graft in Chronic Obstructive Pulmonary Disease: Review Article

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## ABSTRACT

**Background:** A coronary artery bypass graft (CABG) is a significant operation in which healthy blood vessel tissue is used to bypass a patient's blocked coronary arteries.
**Objective:** Review of literature about clinical outcomes of coronary artery bypass graft in chronic obstructive pulmonary disease.
**Methods:** We searched PubMed, Google Scholar, and Science Direct for relevant articles on Coronary Artery Bypass Graft and Chronic Obstructive Pulmonary Disease. However, only the most recent or thorough study was taken into account between January 2008 and January 2023. The authors also evaluated the value of resources culled from other works in the same genre. Therefore, documents written in languages other than English have been ignored due to a lack of translation funds. Unpublished works, oral presentations, conference abstracts, and dissertations were generally agreed upon not to qualify as scientific research.
**Conclusion:** Bypass surgery improves cardiac function, viability, and anginal symptoms by re-establishing blood supply to the ischemic myocardium. Although coronary artery bypass grafting (CABG) surgery remains the most common major surgical procedure, its popularity has been declining in recent years due to the rise in the use of non-invasive procedures including medicinal therapy and percutaneous coronary intervention (PCI). Remodeled airways, fueled by inflammation and angiogenesis, can have unfavourable consequences for organs outside of the lungs in people with chronic obstructive pulmonary disease.
**Keywords:** Coronary artery bypass graft, Chronic obstructive pulmonary disease.

## INTRODUCTION

In both the industrialised and the developing world, coronary artery disease (CAD) is the leading cause of death among cardiovascular diseases. Stable angina, unstable angina, myocardial infarction (MI), and sudden cardiac death are all symptoms of coronary artery disease (CAD), an atherosclerotic illness with an inflammatory component. High blood pressure, high cholesterol, smoking, diabetes, and a family history of heart disease are all risk factors for CAD. A combination of a physical examination, blood tests, and imaging procedures like an electrocardiogram (ECG) or coronary angiography is typically used to diagnose CAD. Alterations to one's way of life, medicine, and surgical treatments like angioplasty and coronary artery bypass grafting are all viable choices for treating CAD [1].

Major surgery known as coronary artery bypass grafting (CABG) involves bypassing atheromatous obstructions in coronary arteries using harvested venous or arterial conduits. Bypass surgery improves cardiac function, viability, and anginal symptoms by re-establishing blood supply to the ischemic myocardium. Coronary artery bypass graft (CABG) operation is the most common major surgical surgery, with almost 400,000 performed annually. However, surgical trends have dropped as medical treatment and percutaneous coronary intervention (PCI) have gained in popularity [2, 3].

### Indications:

When percutaneous coronary intervention (PCI) has failed to unblock blockages in any of the major coronary arteries, bypass surgery is sometimes indicated as a next step. The following are ACCF/AHA Guidelines for Class 1 [4]:

- The prevalence of left main illness is greater than 50%.
- Greater than 70% blockage of all three coronary arteries, with or without involvement of the proximal LAD.
- Two-vessel disease, or blockage of the LAD and another major artery
- Patients with severe anginal symptoms despite aggressive medical treatment who have one or more major stenosis greater than 70%.
- Sudden cardiac arrest survivor with ischemia-related ventricular tachycardia and single-vessel damage more than 70% [4].



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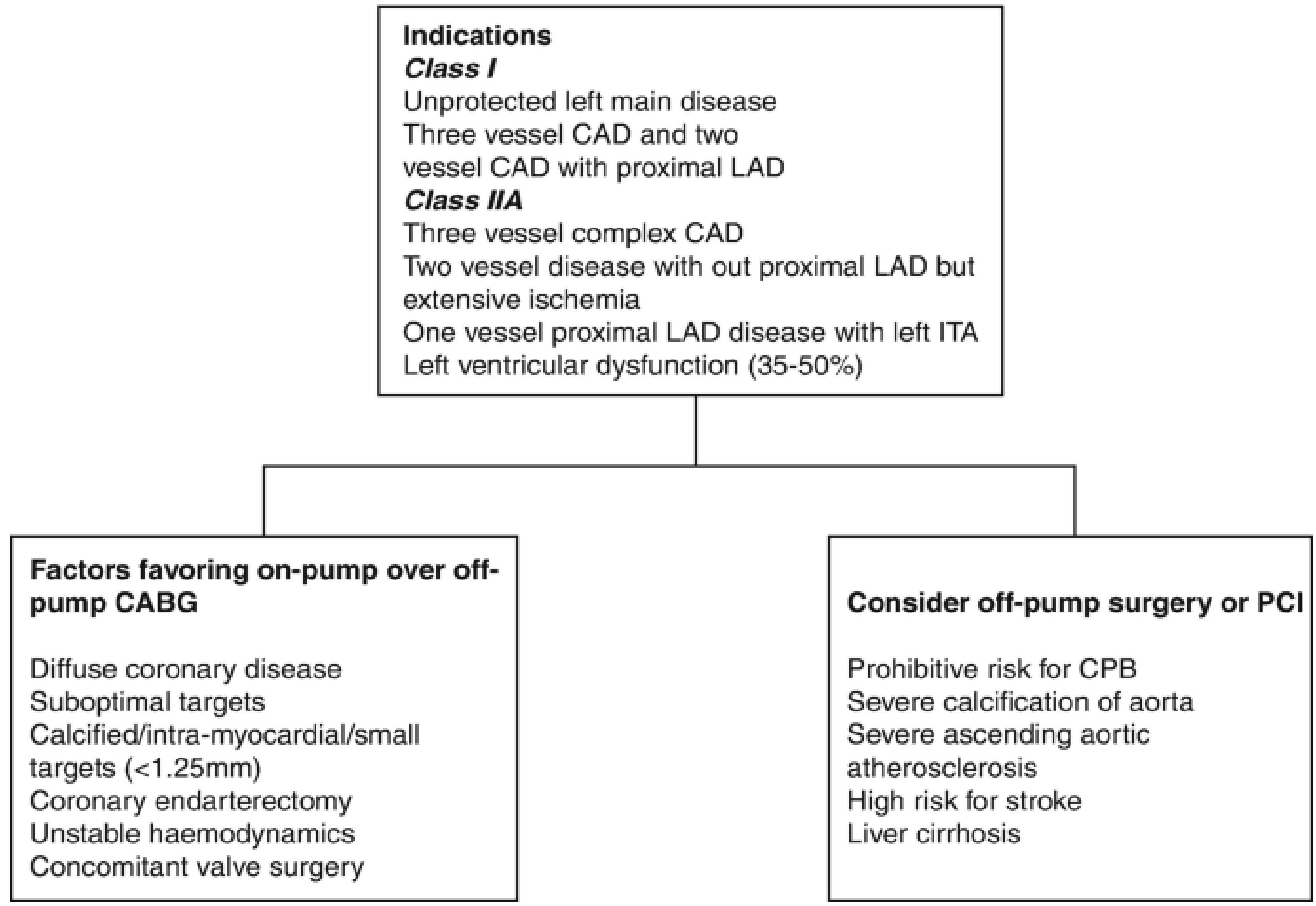


**Fig. (1):** Patient selection algorithm for coronary artery bypass grafting [5].

**Types of CABG:**

Conventional CABG, "off-pump," and minimally invasive CABG are the three main subtypes of CABG surgery. All of these procedures take a long time and involve substantial danger. All require extensive post-operative care and recuperation time under general anaesthesia.

Traditional CABG entails cutting into the sternum to reach the heart, medicating the patient to stop their heart from beating, and hooking them up to a cardio-pulmonary bypass (CPB) machine to keep their blood oxygenated during operation.

Then the arteries in the chest, the arms, or the legs are taken. The blocked blood arteries of the heart are circumvented by grafting these conduits. After the heart has been given the oxygen it needs, the chest is drained and the bone is wired shut.

The difference with off-pump CABG is that the patient's heart is allowed to continue beating throughout the procedure. Both on-pump and off-pump CABG are feasible treatment options with equivalent outcomes.

To reach the heart, surgeons performing minimally invasive CABG make a series of tiny cuts in the skin. Despite its usefulness in a number of situations, not all patients should have this surgery [6, 7].

**Operative technique of Conventional CABG:**

The most common incision for CABG is a sternotomy. A supine position is maintained, with the patient's arms restrained at his sides. A vertical cut is made through the middle of the patient's chest, from the sternal notch to the xiphoid process. The midline is then located, and a powered electric or air saw is used to cut the sternum. To stop the bleeding, the bone marrow can be sealed with towels, antibiotic paste, or bone wax. The sternum is retracted gradually and slowly using a specialised retractor. Retraction sutures are used to open the pericardium and form a cradle, providing better access to the heart. The aorta is then secured at both ends with two purse strings that pass through the aortic media [8]. To insert the aortic cannula, a tiny incision is made in a disease-free section of the ascending aorta. The cannula is gently inserted and fastened in place. Epiaortic ultrasounds are used to locate a safe site for cannulation and aortic cross clamping in individuals with severe aortic atherosclerotic disease. Both the right atrium and the left atrium can be cannulated at the same time. The right atrium is dilated and a vertical incision 2 cm in length is created to implant the cannula. In cases where better venous drainage is required, an SVC cannula may be added to a preexisting dual-stage cannula [9].

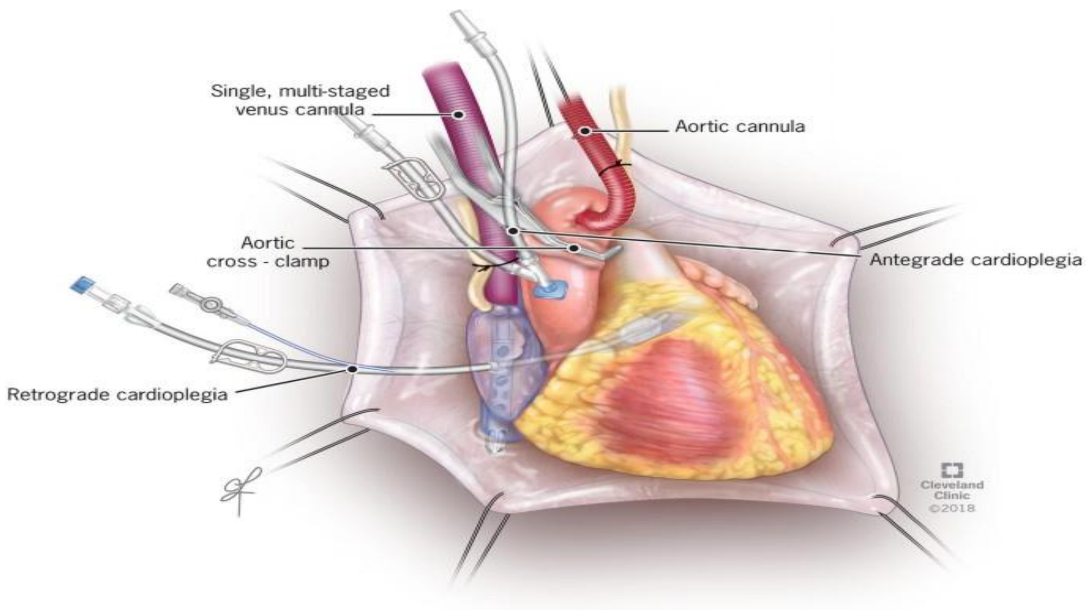


**Fig. (2):** CABG-related conduits [5].

After cardioplegia cannulae (both antegrade and retrograde) have been inserted, cardiopulmonary bypass (CPB) can begin. To induce diastolic myocardial arrest, the aorta is cross clamped, and an induction dosage of 700-1000 mL of antegrade and retrograde cardioplegia is given. The doses utilised for induction and maintenance are specific to the cardioplegia technique. Patients with myocardial protection concerns are the only ones for whom hypothermia is recommended. Before administering heparin, the surgeon will have already decided on the conduits to be used and will have harvested them in preparation for anastomoses. To locate the targets, wet sponges are placed behind the heart, and the heart is gently lifted [10].

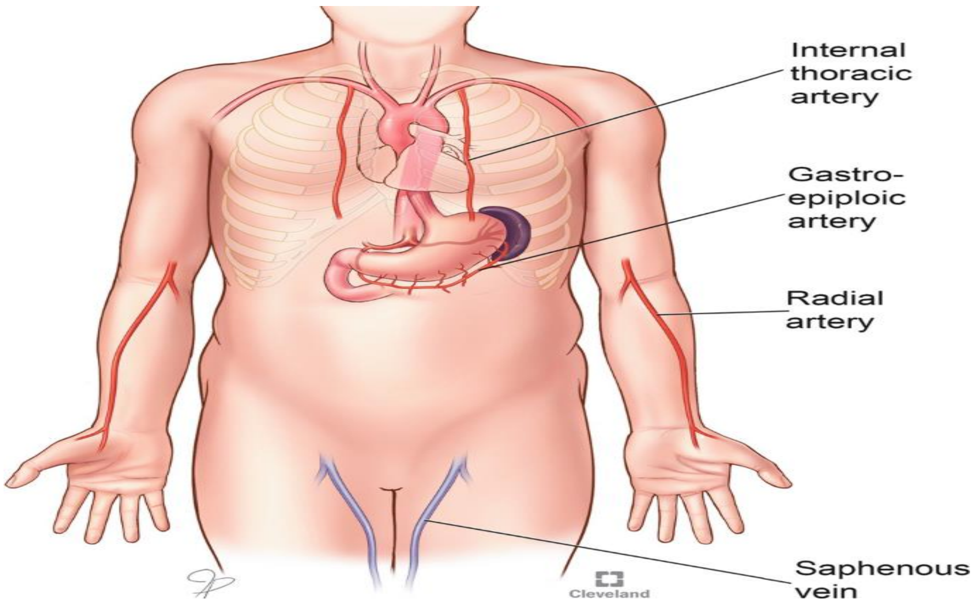


**Fig. (3):** Intracardiac and vascular cannulae used for CPB [5].

In order to better expose the coronary arteries, the pericardium is pushed up on either the left or right side of the heart. Accuracy requires using an optical magnification (2.5-3.5) for close inspection. To prepare for distal anastomosis, the fatty tissue around the coronaries can be retracted or kept away using a 5/0 suture. The coronary artery lumen is accessed by gliding the belly of a No. 15 blade over its surface and into the vessel. Fine coronary artery scissors are used to expand the arteriotomy such that it roughly corresponds to the diameter of the conduits. After that, the surgeon will perform distal anastomoses by beveling the saphenous vein graft's (SVG) edge and stitching the graft to the host vessel with 7/0 flowing fine suture (or 8/0 polypropylene if the host vessel is small or fragile). Then, the operator can use end-to-side and side-to-side anastomoses to carry out composite grafts, such as a sequential or Y-graft. During arterial grafting of the circumflex coronary artery, the in-situ right ITA is often tunneled into the transverse sinus. Left internal thoracic artery (LITA) to left anterior descending coronary artery (LAD) grafts, with veins supplying the other targets, are the most common type of transplant performed in North America [11].

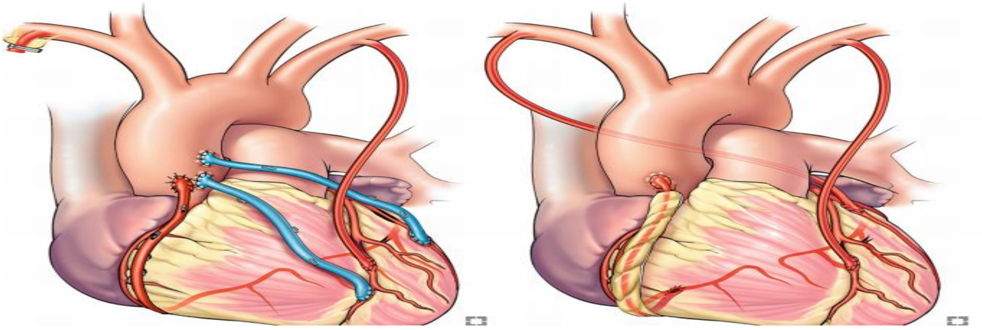

**Fig. (4):** Multiple channels in one graft. Two saphenous vein grafts and a free right ITA can be seen on the left. In situ right internal thoracic artery (ITA) bypassing an occluded or more than 90% stenotic transverse sinus and radial artery graft [5].

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The advantages of multi-arterial grafting are becoming increasingly evident (with right ITA or radial artery in addition to gold standard LITA-LAD graft). Patients who received either a single ITA or a bilateral ITA had similar 10-year survival rates, therefore the 10-year outcomes of the ART experiment are eagerly awaited for later this year. The aorta is then cut open, and the grafts for the coronary arteries are positioned anteriorly or laterally. In cases of severe aortic atherosclerosis, the proximal anastomoses can be built as a T or Y graft to the in-situ LITA or the proximal end of other completed grafts. De-airing is done routinely before and after the cross clamp is removed to prevent air embolism. Transesophageal echocardiography is used to monitor the air removal while needles are used to de-air individual grafts and the aortic root is vented with passive ventricular filling by partially clamping the venous line and with the Valsalva maneuver on the ventilator (TEE). The Trendelenburg posture, shaking the heart, and inserting a needle into the left ventricle are all further options. After the myocardium has been reperfused with warm cardioplegia (300-400 mL), the aortic clamp is released [12].

The surgeon then resume ventilation and wean from CPB after: (1) Get your heart rate back up to normal and back into sinus rhythm with temporary pacing wires. (2) Returning the body's temperature to a normal range. (3) Hematocrit, potassium, glucose, and arterial blood gas levels were all adjusted. (4) Systolic function evaluation and exclusion of new wall motion anomalies by transesophageal echocardiography [13].

Protamine will be administered when the arterial and venous cannulae have been removed. Correction of coagulopathy should not be slowed down by operations like rewarming or chest tube installation. Four to eight stainless steel wires are used to span the intercostal space at right angles, either in a straight line or a crisscross pattern. After making sure there is no bleeding on the retrosternal side of the wire, hemostasis is accomplished. Wires are twisted and cut when the sternal halves have been brought very near together. Sutures are used to close the skin and the subcutaneous tissue beneath it. Avoid transfusions unless medically essential [14].

**STS Score:**

The STS Score was developed by the Society of Thoracic Surgeons to estimate the potential for complications and mortality after coronary artery bypass graft (CABG) surgery. The STS score considers multiple variables, such as the patient's age, medical history, and the degree of surgical difficulty. Various risk variables are weighted differently in the STS score calculation. The overall score can be anywhere from 0 to 100, with higher numbers signifying a more dire prognosis. The STS score was developed to aid in the discussion and evaluation of potential complications that may arise after coronary artery bypass grafting (CABG) surgery. It not only measures the risk of complications such as prolonged breathing and renal or neurological problems, but also predicts surgical mortality in patients receiving CABG [15, 16].

**EuroSCORE:**

Coronary artery bypass graft (CABG) surgery is just one example of the many cardiovascular procedures for which the European System for Cardiac Operative Risk Evaluation (EuroSCORE) is used to forecast the chance of complications and death. The EuroSCORE was created by the ESC and the European Association for Cardio-Thoracic Surgery (EACTS), and is now widely used across Europe and beyond [17, 18].

The first version of EuroSCORE has been retired in favour of the newer and improved EuroSCORE II. EuroSCORE II determines a patient's risk of death in the first 30 days after surgery by analysing demographic information, laboratory results, and diagnostic test results. Scores higher than 10 indicate an increased likelihood of mortality. Patient age, comorbidities, ejection fraction, and surgical urgency are just few of the additional risk factors taken into account by the EuroSCORE II. The EuroSCORE II is an updated version of the STS score that can be used to help doctors and patients talk about the risks of CABG surgery. However, like the STS score, it should be used in conjunction with other data before a final choice is made [18, 19].

**Outcomes:**

***(1) Hospital Mortality:***

Patient comorbidities and hospital volume are the main determinants of the 0.4–5% operative mortality range for CABG, as reported by US data registries. Renal function, age, left ventricular ejection fraction (LVEF), history of cardiac surgery, and nonelective status are the most significant predictors of operational mortality. Inversely correlated with surgical mortality, surgeons' individual procedural volumes have been found to be significantly connected with hospital volumes [20, 21].

Age, gender, acuity of operation, left ventricular function, previous operation, left-main coronary artery disease, and the number of diseased coronary arteries (70%) are all strongly predictive of 30-day and in-hospital mortality following CABG, according to a Working Group panel on the cooperative CABG database project. Risk-adjusted outcomes have become the gold standard quality measurement for CABG, with the STS database serving as the largest voluntary national database from which such predictions may be made for a given patient (based on their risk profiles). The reported mortality rate in CABG ranges from 3% to 7% in most recent series [22].

***(2)* Clinical outcomes of CABG in COPD:**

Clinical research shows that COPD is a common co-morbid condition among patients receiving CABG, with a frequency between 4% and 20%. Historically, chronic obstructive pulmonary disease was thought of as a surgical red flag for CABG. COPD has been linked to higher postoperative mortality and morbidity in CABG patients, including mechanical ventilation for longer than necessary, respiratory failure, and atrial fibrillation [23].

Chronic obstructive pulmonary disease (COPD) is defined by chronic airflow limitation and the remodeling of small airways. Chronic hypoxia caused by airflow restriction in the lungs of a COPD patient raises ACE activity, which may have deleterious effects on oxygen delivery to the body's periphery and respiratory muscle function. Pulmonary vasculature may experience inflammation, cell proliferation, hypertrophy, and constriction if the renin-angiotensin system (RAS) is activated. Aldosterone, which also binds to mineralocorticoid receptors and promotes signaling pathways that contribute to vascular remodeling, was found to have a comparable effect on the pulmonary vascular network [24].

Inflammation may contribute to angiogenesis by activating inflammatory cells and elevating levels of angiogenetic mediators, two of the pathogenic lung tissue remodeling mechanisms that were discussed in the introduction. Airway remodeling due to angiogenesis and inflammation likely contributes to COPD's negative effects on extrapulmonary organs. Therefore, severe lung disease, such as COPD, has historically been seen to pose a risk to heart surgery patients [25].

Individuals with COPD who undergo CABG were found to have a higher chance of experiencing postoperative morbidity and/or mortality compared to patients without COPD. Although CABG used to carry unacceptable morbidity and mortality rates in high-risk patients, recent advancements in anaesthetic, cardiac protection, and surgical procedures, as well as preoperative pulmonary diagnosis and medication optimization, have made this procedure feasible again [26].

Mortality and morbidity rates after surgery are not increased for individuals with mild to severe COPD or even COPD, according to accumulating evidence [26, 27]. COPD may be a risk factor for death after coronary artery bypass graft surgery, according to a recent study [28]. Thus, findings in this area are contentious [23, 29, 30].

## CONCLUSION

As blood flow is restored to the ischemic myocardium, function, viability, and anginal symptoms are improved. Despite the fact that CABG is the most common major surgical surgery, with almost 400,000 performed annually, surgical trends have dropped due to the rising use of medical treatment and percutaneous coronary intervention (PCI). Airway remodeling due to angiogenesis and inflammation likely contributes to COPD's negative effects on extrapulmonary organs.

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