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# The Pathogenesis and Surgical Nursing of Coronary Heart Disease (CHD)

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**Abstract.** Coronary Heart Disease (CHD) stands as a significant global health concern, being the leading cause of mortality worldwide. This paper delves into the multifaceted aspects of CHD, exploring its pathogenesis, clinical manifestations, and treatment modalities, with a particular focus on coronary artery bypass graft (CABG) surgery. The pathogenesis of CHD is complex, involving factors such as atherosclerosis, cognitive dysfunction, cerebral small vessel disease, high platelet activation, and chronic inflammation. Clinical symptoms range from insidious presentations to acute coronary syndrome and sudden death. CABG, a pivotal intervention, is discussed extensively, covering preoperative assessments, intraoperative procedures, and postoperative care. Both on-pump and off-pump CABG techniques are examined in detail, highlighting their respective benefits and risks. Postoperative care involves meticulous monitoring and management to ensure optimal recovery. Additionally, strategies for the clinical enhancement of prevention are outlined, emphasizing lifestyle modifications and risk factor management. This comprehensive exploration aims to deepen understanding, stimulate further research, and guide clinical practice in combating CHD.

**Keywords:** CHD; pathogenesis; postoperative care.

## 1. Introduction

Cardiovascular disease (CVDs) refers to diseases issued with the heart and blood vessels. This happens when plaque accumulates in the blood vessels that supply the heart muscle, narrowing or blocking them. This may result in the heart receiving less blood, resulting in angina, shortness of breath, heart attack, or even death if left untreated [1]. According to the World Health Organization, there are an estimated 17.9 million deaths every year, and CVDs are the world's leading cause of death [2]. Globally, it was estimated, that 244.1 million people worldwide had ischemic heart disease (IHD), commonly known as coronary heart disease (CHD), in 2020. Males were more likely than females to have the condition, with 141.0 and 103.1 million people in each case [3]. Making CHD one of the most common CVDs worldwide causing many deaths. With changing lifestyles and an aging population, CHD is becoming more common, becoming an important risk to global health. In this case, a comprehensive study into coronary heart disease and its treatments is especially important.

The development of CHD involves a variety of factors, including hypertension, hyperlipidemia, diabetes mellitus, cigarette smoking, and poor dietary habits, which are often interrelated to form a complex pathophysiologic process. An in-depth study of the interactions among these factors helps formulate preventive strategies to reduce the incidence of CHD and the associated cases of death and disability. Although there are many treatments for CHD, bypass surgery was used as the most common and important treatment. It works by creating a new path for blood to flow around a blocked or partially blocked artery in the heart to restore normal blood supply to the heart. This type of treatment is very effective and simple, achieving remarkable application effects in clinical practice. However, there are still some controversies and challenges regarding its indications, surgical outcomes, and complications. It objectively evaluates the benefit of cardiac bypass surgery in clinical practice. Providing physicians and patients with more scientific therapy options. By systematically researching the fundamentals of the procedure, its clinical application effects, and its comparison with other therapeutic procedures [4].

Therefore, this paper aims to have a comprehensive understanding of CHD and its treatment methods and explore in depth the principles, clinical application effects, advantages, and limitations of heart bypass surgery, as well as the importance of postoperative care (including pain management, wound care, psychological support, and other aspects). The goal is to provide readers with a comprehensive and specific study that sparks further interest in this important area and provides a useful reference for future research and clinical practice.

## 2. Pathogenesis of Coronary Heart Disease (CHD)

CHD is caused by plaque formation in the walls of the coronary arteries, which deliver blood to the heart (known as coronary arteries). Buildup of plaque narrows the inside of the arteries over time, restricting blood flow fully or partially, calling this process atherosclerosis [5]. CHD is the most frequent type of organ disease caused by atherosclerosis, a common disease that seriously threatens people's health.

According to research, 28% to 51% of patients with CVDs have cognitive dysfunction along with their illness. Meanwhile, people with heart failure may have a 1.64 times increased chance of dying if they have cognitive dysfunction. CHD is associated with cognitive dysfunction in 35% to 53% of the population. Atherosclerosis raises the risk of dementia and causes a decline in cognitive function. The most prevalent kind of atherosclerotic disease is CHD, and there is a significant correlation between the extent of cognitive dysfunction and CHD intensity [6].

The pathogenesis of CHD is an extremely complex process that affects patients with cognitive dysfunction. The pathogenesis includes Cerebral small vessel disease where the cerebral small channel disease and CHD patients may share a similar etiology for cognitive dysfunction. A significant rise in β-amyloid deposition and disruption of the blood-brain barrier are the results of cerebral small vessel disease [7]. Atherosclerosis, Patients with extensive atherosclerosis have a two to three times higher risk of AD compared to those without the disease, and there is an even greater risk of vascular cognitive dysfunction. Cognitive disturbance brought on by atherosclerosis may have a pathogenic etiology involving endothelial dysfunction [8]. High platelet activation, where the level of cognitive impairment can be independently predicted by platelet activity. Patients with cognitive dysfunction and CHD have highly activated platelets. These platelets can cause intracerebral paravascular inflammation through P-selectin and IIb/IIIa receptors, which accelerates the course of dementia [9]. And chronic inflammation where it has been found that cholesterol-25-hydroxylase may be a mediator of the immune-inflammatory process that causes AD. A potential pathogenic link between coronary heart disease and cognitive dysfunction is inflammation [10].

## 3. The Clinical Symptoms of CHD

There are five clinical symptoms of CHD. Acute coronary syndrome is a clinical condition characterized by coronary atherosclerosis plaque rupture, thrombosis, or vasospasm that results in acute or subacute myocardial ischemia, including unstable angina and acute myocardial infarction. Acute coronary syndromes are the primary cause of heart disease-related death, contributing to 30% to 40% of people with CHD. Acute myocardial infarction affects around 1.5 million Americans annually, or one case every 20 seconds and roughly one-third of these individuals pass away [6]. Angina pectoris happens as a condition resulting from increased myocardial stress brought on by myocardial acute, transitory ischemia, and hypoxic clinical syndrome, based on coronary artery stenosis. The most common of these is the angina type, and the most serious are the two types of myocardial infarction and sudden death. Acute transient myocardial ischemia and hypoxia can result in a series of syndromes known as angina pectoris. These include (1) Chest compression, suffocation, swelling, and intense searing pain. The discomfort can be eased on its own and typically lasts 1 to 5 minutes, sometimes up to 15 minutes; (2) The little and ring fingers, the left shoulder, and the front and inner side of the left arm are frequently affected by pain; (3) The pain subsides after a few minutes of rest or the administration of sublingual nitroglycerin when the heart load increases, which includes

greater physical activity, intense mental stimulation, and cold; (4) The symptoms of collapse, perspiration, shortness of breath, anxiety, palpitations, nausea, or dizziness may or may not accompany a pain attack [11].

Myocardial infarction is caused by CAD, which results in a severe and prolonged acute ischemia of the corresponding myocardium, ultimately leading to myocardial necrosis. One of the most important signs of CHD is myocardial infarction. Usually, it is brought on by recurrent episodes of angina pectoris that get worse. Although this is the deadliest scenario and frequently results in sudden mortality from lack of preparation, there are also examples of abrupt myocardial infarction without a history of angina pectoris. The following are the signs and symptoms of a myocardial infarction: (1) sudden, intense pain in the substernal or precordial area that radiates to the left shoulder, left arm, or elsewhere; (2) shortness of breath, nausea, dizziness, and excessive sweating; (3) clammy, gray, and extremely sick skin;(4) Syncope or shock represents about 10% of the patients' only symptom [12].

Insidious type is when the patient has coronary atherosclerosis, but there are no sensations of pain because the lesion is small or there is good collateral circulation, or the patient has a high pain threshold. The type of heart failure (ischemic cardiomyopathy) myocardial fibrosis, a prolonged lack of blood supply to the heart, nutritional problems leading to myocardial atrophy, or fibrous tissue development following a significant myocardial infarction. Sudden death type patients who experience sudden cardiac arrest do so as a result of coronary artery spasm or embolism brought on by atherosclerosis. This causes acute myocardial ischemia, which in turn causes local electrophysiological disorders and transient severe cardiac arrhythmia [12].

## 4. Cardiac Bypass and Preoperative & Postoperative care

### 4.1. Coronary Artery Bypass Graft (CABG)

CABG is a typical treatment for CHD. CABG is a procedure in which a section of blood vessel from another part of the patient's body is connected to each end of a narrowed or blocked coronary artery, allowing blood flow to bypass the bridge and provide oxygen to the ischemic myocardium while relieving myocardial ischemia symptoms. This is a more intrusive yet successful cardiac surgery treatment. Patients with severe CHD (left major lesions, chronic occlusive lesions, diabetic multibranch vasculopathy) who are not candidates for stenting are the main patients for it.

CABG might be recommended if the patient meets the following conditions: the patient’s main heart artery is being blocked, where this artery plays a significant role in supplying a lot of blood to the heart muscle; Severe narrowing of the main heart artery; Severe chest pain caused by the narrowing of multiple cardiac arteries. The narrowing of the heart arteries, reduces the amount of blood flowing to the main heart, even during light exercise or resting; More than one diseased coronary artery and a weak function of the left lower chamber of the heart; A heart artery that is blocked and cannot be repaired with coronary angioplasty. This less invasive procedure expands the artery by using a balloon at the end of a narrow tube known as a catheter. Usually, a stent—a tiny coil—is used to maintain the artery open; An unsuccessful angioplasty, whether or not a stent is used. For instance, following stenting, an artery narrowed once more [13].

Several studies have consistently highlighted the superior efficacy of CABG over medical therapy for CHD, especially in high-risk patients. These studies have shown significant improvements in survival rates among high-risk patients undergoing CABG compared to those receiving medical therapy alone. For instance, one study reported lower mortality rates with CABG at five years (10.2% mortality for CABG vs. 15.8% mortality for medical treatment, $p < 0.001$), seven years (15.8% vs. 21.7%, $p < 0.001$), and ten years (26.4% vs. 30.5%, $p < 0.05$). These findings underscore the substantial benefit of CABG in improving long-term survival outcomes for high-risk CAD patients when compared to medical therapy alone [14].

### 4.2. Preoperative Care

In the days before surgery, specific details of the medical history were needed and go through a physical examination, multiple heart tests and blood tests were required, for example, the chest X-ray and electrocardiogram (ECG) to assess the size and shape of the heart and aorta [13,15]. What's most important is to determine the location and degree of coronary artery stenosis by assessing using coronary artery, left ventricle, internal breast arterial angiography, and other tests. The amount and location of bypass grafts are next decided [16]. Apart from standard pre-operative tests, patients undergoing heart bypass surgery should have their heart function as well as the precise level and extent of their coronary artery stenosis evaluated. To determine the blood artery's function, imaging is also necessary for the blood vessel that will be used as a backup for the bypass. Using the examination results as a guide, create an operation and emergency response plan [16]. The patient should avoid overly mental stress, which can easily cause coronary artery spasms, which increases the risk of myocardial infarction, and practice abdominal breathing before the operation. The patient should also stop taking aspirin and other medications at the same time [16].

### 4.3. Intraoperative

CABG is a major surgery. The surgeon is a medical professional with training in cardiovascular surgery, or heart surgery. A cardiologist (a specialist in heart disease) and other healthcare professionals make up the care team [13]. Before entering the operating room, you will put on a hospital gown and empty your bladder. A health care provider will place an IV (intravenous) line in your hand or arm and administer a sedative injection to help you relax [12,16]. In order to draw blood samples and monitor your heart and blood pressure, more catheters will be put into your neck and wrists [17]. After entering the operating room Patients are given a cocktail of drugs through an IV and wear a breathing mask. These drugs reduce your pain threshold and provide a deep sleep state, referring to this as general anesthesia [17]. Throughout the surgery, the anesthesiologist will continuously monitor your blood oxygen levels, respiration, heart rate, and blood pressure. A breathing tube is inserted into your mouth by physicians, who then attach the other end to a ventilator. The machine keeps the patient breathing during surgery and for a while afterward. Urine is drained from your bladder by inserting a catheter. An antiseptic solution will be used to clean the skin around the surgery site. Throughout surgery, your body continues to get blood and oxygen flow due to a heart-lung machine. This procedure is known as CABG on-pump. The patient's wrists or one of the legs may be sliced by the surgeon when all the tubes and monitors are in place. This is to get into the blood arteries that are used for transplants. After cutting these wounds closed, surgeons will remove blood vessels. From above the sternum to below the end of the breast, the surgeon will make an incision in the middle of the patient's chest. The sternum, or breastbone, will be split in two lengthwise by the surgeon. The heart will be visible as the surgeons separate your sternum [17]. Physicians will use medication to momentarily stop the heart and start the heart-lung machine after opening the chest [13].

The most conventional approach of doing bypass surgery is on-pump CABG. But because of the inflammatory repercussions that follow, which result in renal failure, gastrointestinal distress, and cardiac irregularities, the surgeons are now forced to search for alternatives to the treatment [18]. When compared to off-pump CABG, on-pump CABG results in improved revascularization, but off-pump CABG has much reduced post-operative morbidity and death, particularly in high-risk patients. Although there are several new access techniques available, the majority of CABGs are performed using the midline sternotomy approach (down the middle via the breastbone) [19]. Since both approaches are nearly equally effective, the technique chosen should be based on how simple the surgery is for the surgeon to do [14].

#### 4.3.1. CABG surgery, on-pump procedure.

On-pump CABG is a time-honored procedure that involves stopping the heart. When the heart stops beating, the remaining parts of the body still need blood. Hence, the cardiopulmonary bypass machine,

sometimes referred to as the heart-lung machine or the pump, is a device used by surgeons that works as a substitute for the heart and lungs. In order to drain dirty blood to the pump, where it is cleaned and pumped back into the patient, pipes (cannulas) are inserted into the heart. Thus, specific drugs that both keep the heart stopped and nourish it while it is still can be used to safely stop the heart. After that, the bypass grafts are built. The heart is restarted after the surgery. The cardiopulmonary bypass machine's pipes are removed from the heart once it is operating at an acceptable level again. On-pump CABG nowadays is a safe surgery with a low risk of mortality and complications. For a patient at low risk, the surgery carries an average risk of 1% to 2%. These dangers are heightened by the patient's other potential health problems [19]. Significant side effects from this treatment include bleeding, stroke, liver or renal failure, and a decline in higher mental function [18]. The usage of the pump and the requirement to operate on the patient's heart and major arteries to get them on the system have been blamed for these issues. The heart-lung machine has become pretty secure due to advancements in technology. Surgeons are aware of the many causes of problems, how to spot them, and how to take the appropriate safety measures [20].

### 4.3.2. CABG surgery, off-pump procedure.

Off-pump CABG is thought to be a more recent technique to perform CABG. The invention of this procedure was prompted by the difficulties associated with on-pump CABG, particularly the reduction in higher mental function and stroke [19]. A CABG performed without the use of a heart-lung machine is referred to as an off-pump CABG. This indicates that throughout the entire process, the heart is still pumping blood to the body [21]. Attaching grafts to the heart while it is beating and pumping blood presents a new level of complexity, while it eliminates the need for artificial circulation, the deployment of specific machine pipes, and unnecessary aortic manipulation [19]. Off-pump CABG is a surgical treatment used to restore blood flow to the coronary arteries. An artery or vein is taken from another location in the body by the surgeon. To restore regular blood flow to the heart, the surgeon then utilizes the vessel to "bypass" the blocked section of the vessel. Surgeons may do off-pump CABG using the typical, standard surgical method. This kind of CABG involves the physician making a big cut down the front of the chest through the breastbone. Some surgeons have recently begun utilizing smaller incisions to do off-pump CABG surgeries. In this situation, the procedure is performed through a comparatively tiny rib incision made by the surgeon. One kind of surgical procedure that is minimally invasive is this one. Pain and healing time are decreased by doing this [21]. To perform suturing on a somewhat immobile platform, specialized equipment can mechanically maintain the required cardiac region [22]. There have been worries that the quality of these grafts may be reduced by poor grafting technique brought on by continuous motion. However, surgeons who have modified this approach provide remarkable outcomes [23]. Even in highly skilled surgeons, after the off-pump CABG, the mortality and complications are about 1-2% in patients with low-risk. In any case, this is a very specialized technique that is being performed successfully by select qualified surgeons [24].

In emergency circumstances, an on-pump bypass is preferable to an off-pump bypass. Because doing off-pump procedures seems to be ineffective, adding more burden to an already ischemic heart seems counterproductive. Further studies showed that in emergency conditions, individuals undergoing OFCAB had a considerably lower mean ejection fraction (28% +/- 9% vs. 39% +/- 10%) than those undergoing ONCAB. Additionally, they demonstrated that the use of cardiopulmonary bypass (CPB) equipment during emergency procedures reduces the chance of re-hospitalization, minimizes heart failure symptoms, and reduces the rate of recurrent angina [14].

## 4.4. Postoperative Care

After CABG, the patient will require roughly one week of hospitalization. If the patient experienced complications or had additional operations done, it might need to stay longer [24]. Patients will be transported to the intensive care unit (ICU) for careful observation after the surgery, followed by the recovery room. The tracing of ECG, blood pressure, various pressure measurements, breathing rate, and oxygen saturation level will all be continuously displayed with machines. Following CABG a

few days must at least be spent in the hospital. Until patients are stable enough to breathe on their own, the patient will most likely have a tube in the neck to assist with breathing through a ventilator. As the patient wakes up from anesthesia and begins to breathe on their own, the physician may modify the breathing machine to allow them to take over more of the breathing. A physician will remove the breathing tube after the patient is conscious enough to breathe entirely on their own and capable of coughing. The breathing tube is often taken out the same day or early the following morning following the procedure. This is the time when the stomach tube will be removed by the provider. Every few hours after the breathing tube are removed, a nurse will assist the patient with coughing and taking deep breaths. It will hurt because of the pain, but the patient must do this to prevent mucus from building up in the lungs and perhaps developing pneumonia. When the patient is stable and the physician removes the stomach and breathing tubes, they may begin to have liquids and eat more solid foods as they get use to them. The patient will be transferred from the intensive care unit to a postsurgical nursing unit when the physician feels that they are ready. There, the healing process will continue. The activities are increased gradually to avoid post-operative problems like blood clots in the patient's legs or pneumonia. A care team member will plan the patient's discharge and set up a follow-up appointment with a physician [17]. The patient will need to keep taking their prescriptions after being discharged from the hospital. Because medication therapy is the foundation of all treatment, even after interventional and surgical treatment, standard long-term medication therapy needs to be continued [25]. After CABG, it's important to collaborate with the physician to support continued health. Some short-term side effects that may occur after surgery include pain around the surgical incision in the chest, constipation, discomfort or itching from the healing wound, loss of appetite, mood swings or depression, pain or tightness in the shoulders and upper back muscles, difficulty sleeping and tiredness, and swelling where an artery or vein was removed for the graft. However, these side effects should go away in four to six weeks [24].

## 5. Clinical Enhancement of Prevention

The two main types of conditions that increase the risk of CHD are those that cannot be changed and those that can. Non-changeable factors include age, gender, and genetic history passed down through the family. Beyond the age of forty, the incidence rate rises, and after the age of forty-nine, the disease increases more quickly. Men experience a greater occurrence rate than women, yet following menopause, women experience a much higher incidence rate. The preventable elements that might quickly result in CHD include smoking, obesity, metabolic syndrome, diabetes mellitus, dyslipidemia, hypertension, etc. Although surgical treatment is effective, it is still necessary to strengthen the prevention of the disease's occurrence. Preventing CHD starts with promoting a healthy lifestyle and changing living habits by restricting smoking and alcohol consumption, and having a low-calorie, low-fat, low-cholesterol, low-salt, high-fiber diet. Other important lifestyle changes include controlling weight in obese individuals, balancing work and relaxation, avoiding intense activity, and taking a bath after a full meal or when feeling hungry. Pay close attention to blood pressure monitoring, routine ECG examinations, blood glucose testing, blood lipid testing, aggressive treatment of hypertension, diabetes, hyperlipidemia, etc., and stringent risk factor management. Take note of weather changes and dress appropriately as cold causes blood vessels to constrict, blood pressure to rise, heart rate to increase, and the pressure on the heart to become worse. A study revealed that the percentage of individuals with asymptomatic heart attacks increased to 45%. Asymptomatic heart attacks typically account for 30%–40% of heart attack cases. Patients with risk factors should thus take early regulations and it is recommended that middle-aged and older individuals have frequent medical exams to prevent CHD [26].

## 6. Conlcusion

CHD poses a significant challenge in healthcare, necessitating a multifaceted approach for effective management. This paper underscores the pivotal role of CABG surgery in addressing CHD, despite persistent challenges and controversies. Comprehensive preoperative assessment and attentive

postoperative care are essential for favorable patient outcomes. Furthermore, efforts to enhance prevention through lifestyle modifications and risk factor management are crucial in reducing the burden of CHD. Looking ahead, future prospects in CHD management may involve advancements in surgical techniques, personalized medicine approaches, and innovative preventive strategies. By synthesizing current knowledge and highlighting areas for further investigation, providing readers with useful references for future research to advancements in CHD management and improves patient care in clinical practice.

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