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An Evolution of Heart Bypass Surgeries and Outcomes of Coronary Artery Bypass Grafts

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Abstract

Coronary artery bypass grafting (CABG) is a major surgical operation where atheromatous blockages in a patient's coronary arteries are bypassed with harvested venous or arterial conduits. The bypass restores blood flow to the ischemic myocardium which, in turn, restores function, viability, and relieves anginal symptoms. Almost 400,000 CABG surgeries are performed each year making it the most commonly performed major surgical procedure, but surgical trends have decreased as the use of alternative options such as medical treatment and percutaneous coronary intervention (PCI) have increased.

Keywords: Myocardial infarction; cardiopulmonary bypass; coronary artery blood flow; cardiac angiography

Introduction

Coronary artery bypass grafting (CABG) is defined as "open-heart surgery in which a section of a blood vessel is grafted from the aorta to the coronary artery to bypass the blocked section of the coronary artery and improve the blood supply to the heart." The pathophysiology of coronary artery disease was established in 1876 by Adam Hammer when he postulated that angina (imbalance of coronary perfusion supply and demand) was caused by interruption of coronary blood supply and that myocardial infarction occurred after the occlusion of at least one coronary artery. In the 19th century heart surgery was performed infrequently and with poor results. In 1896, Stephen Paget wrote that "surgery of the heart has probably reached the limits set by nature to all surgery". In that same year, Ludwig Rehn successfully conducted heart surgery repairing a stab wound. In 1910, Alexis Carrel was the first to describe CABG

Cardiac surgery became more feasible in the late 1930s with the development of the heart-lung machine by Dr. John Gibbon which enabled cardiopulmonary bypass (CPB). In 1950, at McGill University in Montreal, QC, Canada, Vineburg and Buller were the first to implant the internal mammary artery (IMA) into the myocardium to treat cardiac ischemia and angina. In 1953, D. W. Gordon Murray reported placement of arterial grafts in the coronary circulation. Shortly thereafter, in 1955, Sidney Smith was the first to harvest saphenous vein and use it as a graft from aorta to into the myocardium. In 1958, Longmire et al. performed the first open coronary artery endarterectomy without CPB at University of California at Los Angeles (UCLA).

Methods

We conducted a retrospective review of medical, surgical, and intensive care records of consecutive adult patients aged 18 years and older, with obstructive coronary artery disease who underwent CABG surgery at the Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) between 1 January 2000 and 31 December 2017. Data was collected from the cardiothoracic surgery department's pre- and postoperative reports, the cardiology department's medical records, and anaesthesiology's intra-operative reports. We collected demographic, clinical, biochemical, surgical, echocardiographic, and angiographic data.

Induction of anaesthesia was performed with full monitoring using electrocardiography, pulse oximetry, invasive arterial blood pressure, and central venous pressure monitoring. Opioid-based agents, either fentanyl 0.1 mg/kg or 2.5 µg/kg sufentanil, with midazolam 0.05 mg/kg or 0.2 mg/kg etomidate were administered.

Statistical analysis

Continuous variables are summarised as the mean and standard deviation (SD) when normally distributed and as a median and interquartile range (IQR) when the distribution is skewed. We compared normally distributed continuous variables by using the student t-test. The Wilcoxon rank-sum (Mann-Whitney) test was used to compare medians for non-normal data. The preoperative coronary angiogram demonstrated single, double, and triple vessel disease in 72 (5.9%), 238 (19.5%), and 885 (72.7%) patients, respectively. Left main stem disease was noted in 268 (22.0%) patients, and coronary artery bypass graft surgery was performed as a semi-urgent or elective procedure in 81.0% of patients. The saphenous vein was grafted in 1074 (88.2%), the left and right internal mammary artery in 1059 (86.9%) and 82 (6.7%) patients, respectively. Only 123 (10.1%) patients had grafts other than internal mammary artery grafts.

The risk of mortality in patients subjected to CABG surgery depends on the patients' age, comorbidities, physiological functional reserve, degree of left ventricular dysfunction, the surgeons' experience, and the hospital procedure volume. The operative all-cause mortality rate in our hospital was 11.2%. Our mortality rate is significantly higher compared to that reported from other developing and developed countries. Data obtained from 1,145,285 patients referred for CABG in the United States of America (USA), from 1989 to 2004, showed a decline in mortality rate from 5.5 to 3.06%, irrespective of the presence of comorbidities. A review of 17,335 CABG surgeries performed in Spain between 2013 and 2015 demonstrated a crude mortality rate of 5%. Similarly, Swart et al. analysed outcomes post CABG in a South African cardio-thoracic private practice and reported a mortality rate of 3%.

Conclusion

In conclusion, this large CABG cohort with patients from both university and community hospitals and 6 European countries reflects a growing trend in patients referred for CABG with prior PCI (20%) referred because of disease progression despite medical therapy.

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