

EPIDEMIOLOGY

Early Postoperative Complications After Coronary Artery Bypass Grafting at the Cardiovascular Center of Puerto Rico and the Caribbean

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Objectives. This study describes the preoperative cardiovascular characteristics, intraoperative data, in-hospital complications and factors associated to procedural-related complications in patients undergoing coronary artery bypass grafting (CABG).

Background. There is a growing body of evidence of CABG safety and efficacy; however, limited data is available regarding the value of this surgical procedure in the Puerto Rican population.

Methods. We retrospectively reviewed the medical records of 200 consecutive patients submitted to CABG at the Cardiovascular Center of Puerto Rico and the Caribbean over a three-month period in 1997. Bivariate and multivariate analyses were performed to determine factors associated with the occurrence of complications.

Results. The most frequent cardiac risk factor was hypertension (77%); stable angina (60.5%) was the predominant cardiac clinical diagnosis. Three vessel

disease with proximal left anterior descending coronary artery stenosis (42.1%) was the most common anatomical lesion. The rate of major complications such as death (3%), perioperative myocardial infarction (2%), reoperation to control bleeding (1.5%), pulmonary embolism (1%), and stroke (1%) was low and similar to the rate reported elsewhere. Multivariate analysis showed that non-use of LIMA graft, extended hospital stay, prolonged cardiopulmonary bypass time, and left ventricular dysfunction were significantly associated with the occurrence of complications ($p < 0.05$); on the other hand, there was a trend for older age to be associated with the occurrence of complications ($p = 0.057$).

Conclusions. CABG is being performed with an acceptably low complication rate in this institution.

Key words: Coronary artery bypass grafting, Puerto Rico, Angiographic findings, Logistic regression.

Despite the reductions in the age-adjusted mortality rates observed for the past 25 years in the United States, cardiovascular disease continues to be the most serious threat to life and health (1,2). Coronary artery disease (CAD) is the most common and most lethal cardiovascular condition in both sexes in the United States. In Puerto Rico, cardiovascular disease was the leading

cause of mortality in both sexes in 1994, accounting for 20.4% of all deaths reported, and nearly 58% of the deaths were attributed to CAD (3).

Coronary artery bypass grafting (CABG) is a major revascularization procedure for CAD. Indications for this procedure include: 1) multivessel stenoses of at least 50% combined with moderate to severe left ventricular impairment (left ventricular ejection fraction less than 50%), 2) proximal three vessel disease of at least 50%, 3) proximal left anterior descending stenosis of at least 70% in conjunction with other major and significant coronary stenosis, 4) left main coronary artery stenosis of at least 50%, and 5) angina interfering with daily activities and/or severe ischemia by exercise test or resting electrocardiogram with significant coronary artery stenoses (4,5). Since CABG was introduced in 1968, more than a million patients in the United States have undergone this procedure (6). In the early 1990s, CABG was performed at a rate of nearly 380,000 per year in the United

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States (7). Randomized clinical trials evaluating CABG and medical therapy showed that patients with significant left main stenosis or with three vessel CAD with left ventricular systolic dysfunction benefit from surgical revascularization (8). Conversely, no benefit was found in lower risk groups such as patients with single vessel disease. Several studies have also shown that CABG can be performed with acceptable operative morbidity and mortality with excellent long-term results (9-12). The overall operative mortality reported in patients who underwent CABG in the Coronary Artery Surgery Study (CASS), a multicenter study performed in the United States, was 2.37% (9). However, previous studies have shown a higher operative mortality for women, probably related to a smaller body size, more comorbid conditions, older age and delayed referral (13,14). Other studies have shown that symptomatic elderly patients with CAD are at increased risk of procedural-related complications which may impair overall survival (15-18).

Limited data is available concerning the value of this surgical procedure in the Puerto Rican population, an important yet understudied ethnic group. Therefore, this study describes the experience of a sample of 200 consecutive Puerto Rican patients submitted to CABG at the Cardiovascular Center of Puerto Rico and the Caribbean over a 3-month period. The specific aims of the study were to 1) describe the preoperative and intraoperative characteristics of those patients, 2) determine the postoperative complications and 3) evaluate factors associated with the occurrence of complications.

Methods

The medical records of 200 consecutive patients submitted to CABG from March through June 1997 at the Cardiovascular Center of Puerto Rico and the Caribbean were reviewed. A data form was designed to abstract information from the medical records including age, gender, body mass index, primary diagnoses, cardiac risk factors, left ventricular ejection fraction, medical therapy, angiographic findings, surgical characteristics, postoperative complications, and hospital length of stay. Chest roentgenography reports, electrocardiograms, cardiac catheterization reports, hemodynamic data, and pertinent laboratories were reviewed. Patients who underwent valvular surgery, ventricular aneurysmectomy or other cardiac surgical procedure were excluded. Early postoperative complications were defined as any adverse event not present on admission, occurring between the time of surgery and discharge from the hospital. Major complications were defined as death, myocardial infarction, stroke, cardiogenic shock, reoperation to

control bleeding, pulmonary embolism and renal impairment. Left ventricular dysfunction was defined as an ejection fraction $\leq 49\%$. Surgical priority was defined as: emergency surgical procedures (those performed the same day as cardiac catheterization and angiography); urgent procedures (those performed within 2-6 days of cardiac catheterization and angiography), and the remaining procedures were considered elective.

Continuous variables that were normally distributed were expressed as mean \pm standard deviation (SD) and range; those that did not follow a normal distribution were presented as median and range. Frequency distributions were obtained for categorical variables. Factors associated with the occurrence of complications were assessed using unadjusted odds ratios and 95% confidence interval (95% CI) using the Taylor Series Expansion. Variables with a p value < 0.10 in the univariate analyses were included in the unconditional logistic regression analysis. All statistical tests were two-sided. Data entry was performed using Epi-Info 6.04b (19) and analysis was performed using the Statistical Analysis System (SAS) (20).

Results

The mean age of patients was 62.4 ± 9.7 years (range: 35-84). Forty-six percent of patients were 65 years and older. Mean cholesterol level was above 200 mg/dL (206.9 ± 50.6), and the median body mass index was 27.2 kg/m^2 . The most frequent risk factors for CAD were hypertension (77%), male gender (62%) and hypercholesterolemia (52%) (Table 1). Nearly 61% of patients had stable angina as one of the admission diagnosis. Prior to surgery, the most commonly used cardiac antianginal medication was nitroglycerin (70.5%) and nearly 45% of patients had left ventricular dysfunction. The extent of CAD as determined angiographically was as follows: three vessel disease with proximal left anterior descending (LAD) artery (42.0%), two vessel disease with proximal LAD artery (28.0%), LAD disease (11.0%), three vessel disease without proximal LAD artery (10.5%), left main coronary artery stenosis (9.0%) and two vessel disease without proximal LAD artery (4.0%).

Table 2 summarizes selected intraoperative and postoperative characteristics of patients who underwent CABG. The median number of grafts per patient was 3 (range: 1-6). The median cardiopulmonary bypass time was 87 minutes (range: 21-332), whereas the median ischemic time was 55.5 minutes (range: 12-221). The median creatine kinase MB (CKMB) isoenzyme level was 25.9 IU/L. The median postoperative intensive care unit length of stay was 1 day (range: 1-35) whereas the median overall hospital stay was 7 days (range: 1-52). Surgery

Table 1. Demographic and Clinical Perioperative Characteristics of Patients Undergoing CABG.

Characteristic	Number	Percent
Cardiac risk factors		
Hypertension	154	77.0
Male gender	124	62.0
Hypercholesterolemia	104	52.0
Diabetes mellitus	93	46.5
Smoking	79	39.5
Family history of premature CAD	20	10.0
Other cardiac diagnoses		
Stable angina	121	60.5
Q-wave myocardial infarction	66	33.0
Unstable angina	49	24.5
Non-Q wave myocardial infarction	30	15.0
Peripherovascular disease	9	4.5
Congestive heart failure	6	3.0
Cardiac medications		
Nitroglycerin	141	70.5
Aspirin	85	42.5
Beta blockers	84	42.0
Calcium channel blockers	78	39.0
ACE inhibitors	72	36.0
Diuretics	29	14.5
Lipid lowering drugs	23	11.5
Digitalis	11	5.5
Left ventricular dysfunction	89	44.5
Coronary angiographic findings		
Single vessel disease (LAD)	22	11.0
Two vessel disease with proximal LAD	56	28.0
Two vessel disease without proximal LAD	8	4.0
Three vessel disease with proximal LAD	84	42.0
Three vessel disease without proximal LAD	21	10.5
Left main coronary artery stenosis	18	9.0

was elective in 112 patients (56.3%), urgent in 75 (37.7%), and emergent in 12 (6%). A LIMA graft was used in nearly 95% of patients (data not shown).

Table 3 shows the procedural-related complications in patients who underwent CABG. Nearly 38% of patients developed at least one complication. The most common early postoperative complications were atrial arrhythmia (16%) and low cardiac output (12%). Major complications included renal impairment (4%), death (3%), cardiogenic

Table 2. Main Intraoperative and Postoperative Characteristics of Patients Who Underwent CABG.

Characteristic	Median	Range
Cardiopulmonary bypass time (min.)	87.0	21-332
Ischemic time (min.)	55.5	12-221
Number of grafts	3	1-6
CKMB levels (IU/L)	25.9	3.2-928
PRBC* transfusions	1	0-18
ICU length of stay (days)	1	1-35
Hospital length of stay (days)	7	1-52

* Packed red blood cells

Table 3. Procedural-Related Complications of Patients Who Underwent CABG.

Complication	Number	Percent
Atrial arrhythmia	32	16.0
Low cardiac output	24	12.0
Pulmonary congestion	13	6.5
Renal impairment	8	4.0
New right bundle branch block	8	4.0
Prolonged endotracheal intubation	6	3.0
Death	6	3.0
Delirium	6	3.0
Pneumonia	5	2.5
Ventricular arrhythmia	5	2.5
Cardiogenic shock	5	2.5
Pericarditis	5	2.5
Myocardial infarction	4	2.0
Intra-aortic balloon counterpulsation	4	2.0
Reintubation	4	2.0
Reoperation to control bleeding	3	1.5
Cardiac arrest	3	1.5
Cardiac tamponade	3	1.5
Stroke	2	1.0
Pulmonary embolism	2	1.0
Sepsis	2	1.0
Thrombosis	2	1.0
Wound dehiscence	1	0.5

shock (2.5%), perioperative myocardial infarction (2%), reoperation to control bleeding (1.5%), pulmonary embolism (1%), and stroke (1%). Four patients (2%) required intra-aortic balloon counterpulsation.

Bivariate analysis showed that non-use of LIMA graft ($p = 0.021$), hospital stay > 7 days ($p < 0.001$), ischemic time > 55.5 minutes ($p < 0.001$), cardiopulmonary bypass time > 87 minutes ($p < 0.001$), left ventricular dysfunction ($p = 0.0002$), unstable angina ($p = 0.003$), age ≥ 65 years ($p = 0.003$), need for more than 1 unit of packed red blood cells transfusion ($p = 0.004$), and use of more than 3 grafts ($p = 0.039$) were significantly associated with in-

Table 4. Bivariate Analysis of Factors Significantly Associated with the Occurrence of Early Postoperative Complications in 200 Patients who Underwent CABG.

Characteristic	OR*	95%CI*	P*
Non-use of LIMA graft	4.86	1.25-18.92	0.021
Hospital stay > 7 days	4.13	2.24-7.59	<0.001
Ischemic time > 55.5 min.	4.00	2.16-7.39	<0.001
Cardiopulmonary bypass time > 87 min.	3.75	2.04-6.90	<0.001
Left ventricular dysfunction	3.02	1.67-5.48	0.0002
Unstable angina	2.63	1.36-5.09	0.003
Age ≥ 65 years	2.43	1.35-4.38	0.003
PRBC [†] transfusions > 1	2.36	1.31-4.23	0.004
Number of grafts > 3	1.89	1.03-3.45	0.039
Stable angina	0.40	0.22-0.72	0.002

*Odds ratio, 95% confidence interval and p value

[†] Packed red blood cells

Table 5. Multivariate Analysis of Factors Associated with the Occurrence of Early Postoperative Complications in 200 Patients who Underwent Only CABG.

Characteristic	OR*	95% CI*	P*
Non-use of LIMA graft	6.72	1.53-29.5	0.0117
Hospital stay > 7 days	3.88	1.97-7.62	< 0.0001
Cardiopulmonary bypass time > 87 min.	3.16	1.58-6.31	0.0011
Left ventricular dysfunction	2.41	1.23-4.74	0.0106
Age ≥ 65 years	1.92	0.98-3.74	0.0567

*Adjusted odds ratios (OR), 95% confidence interval and p value were derived from a multiple unconditional logistic regression in which each OR was adjusted for all other factors listed.

hospital complications (Table 4). On the other hand, stable angina ($p = 0.002$) was significantly associated with non-occurrence of in-hospital complications. Multivariate analysis showed that non-use of LIMA graft (OR = 6.72, 95% CI = 1.53-29.5, $p = 0.0117$), extended hospital stay (OR = 3.88, 95% CI = 1.97-7.62, $p < 0.0001$), prolonged cardiopulmonary bypass time (OR = 3.16, 95% CI = 1.58-6.31, $p = 0.0011$), and left ventricular dysfunction (OR = 2.41, 95% CI = 1.23-4.74, $p = 0.0106$) were significantly associated with in-hospital complications (Table 5). However, there was a trend for older age to be associated with the occurrence of complications (OR = 1.92, 95% CI = 0.98-3.74, $p = 0.0567$).

Discussion

The medical history of the subjects in this study revealed that hypertension was the most frequent risk factor for CAD, followed by male gender and hypercholesterolemia. This distribution was similar to that reported previously in other studies (13,21). Mean cholesterol level was higher than that recommended by the National Cholesterol Education' Program Adult Treatment Panel (NCEP-ATPII) (22). Since the prevalence of risk factors increases the morbidity, mortality and need for interventions such as repeat CABG, coronary angioplasty or cardiac transplantation, it is imperative for physicians to counsel patients with known significant CAD about the importance of control of modifiable risk factors for atherosclerosis.

Various studies have documented that patients continue to be undertreated and underscreened for cardiovascular risk factors. A recent study indicated that despite the availability of the NCEP-ATPII guidelines and results of primary and secondary prevention clinical trials of CHD, evaluation, counseling, and treatment of patients by physicians remain inadequate (23).

Stable angina and history of myocardial infarction were the most frequent cardiac diagnoses. Classification of indications for CABG for this series of patients was not evaluated due to limited information on specific functional

class and grading of ischemia on non-invasive testing.

Despite the widespread use of newer antianginal medications including beta blockers and calcium channel blockers, nitroglycerin continues to be the most frequently used therapy. Despite evidence of severe CAD in our study population, less than half of patients were using aspirin. Possible explanations for this observation include underprescription or therapy discontinuation in preparation for surgery.

Nearly 80% of patients submitted to CABG had severe and extensive CAD including 42% with three vessel CAD and proximal LAD stenosis, 28% with two vessel CAD and proximal LAD stenosis, and 9.0% with left main coronary artery stenosis. The percentage of triple vessel CAD was similar to that reported in other series of Puerto Rican patients submitted to CABG (21); however, this percentage was higher than those reported by the Bypass Angioplasty Revascularization Investigation (BARI) Investigators, (8) Myers et al. (9) and Hammar et al. (14). This finding may suggest a more aggressive atherosclerotic disease in the Puerto Rican population.

Most of the early postoperative complications such as atrial arrhythmia, low cardiac output, pulmonary congestion and new right bundle branch block were minor and reversible. The rate of major complications such as perioperative myocardial infarction, reoperation to control bleeding, pulmonary embolism, stroke and death was low (<3%) and similar to the rates reported in The Society of Thoracic Surgeons National Cardiac Surgery Database and other institutions (9,17,18,21).

In our patients, non-use of LIMA graft, extended hospital stay, prolonged cardiopulmonary bypass time, and left ventricular dysfunction were significantly associated with the occurrence of complications, and there was a trend for older age to be associated with the occurrence of complications. Prolonged cardiopulmonary bypass time was an independent factor associated with the occurrence of complications, most probably related to ischemic damage to the myocardium and other organs. Previous studies have shown that older age, left ventricular ejection fraction <0.40, and non-use of LIMA to LAD increase the probability of complications after surgery (4,15,18).

It is important to emphasize that physicians managing high risk CAD patients should be aware of the chance of procedural-related complications and its determinants. Although our data show significant associations with the occurrence of complications, these findings need to be confirmed in a larger group of patients. The findings of this study should be interpreted keeping in mind that this was a retrospective analysis of prospectively collected data. This article intends to provide a framework that

physicians can use in combination with other information when they discuss the therapeutic alternatives with their patients.

On the basis of these results, we conclude that CABG is being performed with an acceptably low complication rate at the Cardiovascular Center of Puerto Rico and the Caribbean and comparable to that reported elsewhere (8-12,21). Close and continued follow-up of these patients will further define the long-term postoperative complications, the need for additional surgical or interventional procedures and their quality of life.

Resumen

Este estudio describe las características cardiovasculares preoperatorias e intraoperatorias, las complicaciones intrahospitalarias y factores asociados a la aparición de complicaciones en pacientes que se sometieron a cirugía de puente coronario. Se analizaron los expedientes médicos de 200 pacientes consecutivos que se sometieron a esta cirugía en el Centro Cardiovascular de Puerto Rico y el Caribe en 1997. La hipertensión (77%) fué el factor de riesgo más frecuente y la angina estable (60.5%) el diagnóstico predominante. La enfermedad de tres vasos con lesión proximal de la coronaria anterior descendente (42.1%) fue el hallazgo angiográfico más común. Complicaciones tales como muerte, infarto del miocardio perioperatorio, re-exploración por sangrado, embolia pulmonar y accidente cerebrovascular fueron poco frecuentes. La no utilización de la arteria mamaria como puente, la disfunción ventricular, el tiempo de circulación extracorpórea prolongado y una larga estadía hospitalaria se asociaron significativamente al desarrollo de complicaciones intrahospitalarias. La cirugía de puente coronario según practicada en esta institución constituye un procedimiento de bajo riesgo.

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