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Association of pre and intraoperative variables with postoperative complications in coronary artery bypass graft surgery

Associação de variáveis pré e intraoperatórias com complicações pós-operatórias em cirurgia de revascularização do miocárdio

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Abstract

Objective: To associate the pre- and intraoperative variables with postoperative complications of patients undergoing coronary artery bypass graft surgery.

Methods: The pre- and intraoperative risk factors of individuals of both genders with diagnosis of coronary insufficiency undergoing coronary artery bypass graft have been studied.

Results: Fifty-eight individuals with median age 62 ± 10 year-old were included in the study, 67% of whom were male. Fourteen (24.1%) patients were smokers, 39 (67.2%) had previous myocardial infarction history, 11 (19%) had undergone coronary angioplasty, 74% had hypertension, 27% had diabetes mellitus, 64% had dyslipidemia and 15.5% had chronic obstructive pulmonary disease. Eighteen (31%) patients presented postoperative complications, most frequent being: infection in surgical incision, difficulties in deambulation, dyspnea, urinary infection and generalized weakness. Male patients had fewer complications than females ($P=0.005$). Patients with chronic obstructive pulmonary disease remained hospitalized for longer time periods ($P=0.019$).

Postoperative complications occurred in 50% of the patients with creatinine increased, while only 27.1% of the patients with normal value of creatinine had complications ($P=0.049$). In addition, complications occurred in 50% of the patients with diabetes mellitus, while only 23.8% of patients without diabetes mellitus had complications ($P=0.032$). The intraoperative factors showed no statistically significant differences.

Conclusion: The preoperative factors are associated with postoperative complications in patients undergoing coronary artery bypass graft surgery.

Descriptors: Myocardial revascularization. Coronary artery bypass. Postoperative complications. Risk factors.

Resumo

Objetivo: Associar variáveis pré e intraoperatórias com as complicações pós-operatórias de pacientes submetidos à cirurgia de revascularização miocárdica.

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Abbreviations, acronyms & symbols

AMI	Acute myocardial infarction
BMI	Body mass index
CABG	Coronary artery bypass graft
COPD	Chronic obstructive pulmonary disease
CPB	Cardiopulmonary bypass
DM	Diabetes mellitus
ICU	Intensive care unit
MV	Mechanical ventilation
POD	Postoperative day
SAH	Systemic arterial hypertension

Métodos: Foram estudados os fatores de risco pré e intra-operatórios de indivíduos de ambos os sexos, com diagnóstico de insuficiência coronariana, submetidos à cirurgia de revascularização do miocárdio.

Resultados: Participaram do estudo 58 indivíduos, com idade média de 62 ± 10 anos e 67% eram do sexo masculino. Catorze (24,1%) pacientes eram fumantes, 39 (67,2%) apresentavam história de infarto do miocárdio prévia, 11 (19%) tinham realizado angioplastia coronariana, 74% apresentavam hipertensão arte-

rial, 27% diabetes mellitus, 64% dislipidemia e 15,5% doença pulmonar obstrutiva crônica. Dezoito (31%) pacientes apresentaram complicações no pós-operatório e as mais frequentes foram infecção na incisão cirúrgica, dificuldades na deambulação, dispneia, infecção urinária e fraqueza generalizada. Pacientes do sexo masculino apresentaram menos complicações que os do sexo feminino ($P=0,005$). Pacientes com diagnóstico de doença pulmonar obstrutiva crônica permaneceram maior tempo hospitalizados ($P=0,019$). Complicações pós-operatórias ocorreram em 50% dos pacientes com creatinina aumentada, enquanto que apenas 27,1% dos pacientes com valor normal de creatinina apresentaram complicações ($P=0,049$). Ocorreram também complicações em 50% dos pacientes com diabetes mellitus, enquanto que apenas 23,8% dos pacientes sem diabetes mellitus tiveram complicações ($P=0,032$). Os fatores intraoperatórios não apresentaram diferenças significativas estatisticamente.

Conclusão: Os fatores pré-operatórios estão associados com complicações pós-operatórias em pacientes submetidos à cirurgia de revascularização miocárdica.

Descritores: Revascularização miocárdica. Ponte de artéria coronária. Complicações pós-operatórias. Fatores de risco.

INTRODUCTION

Cardiovascular diseases were considered the main cause of death and disability worldwide in 2010 and represent the highest costs for medical care. In Brazil, according to DATASUS, in 2000, 946,392 death certificates were filed, with 260,595 (27.5%) reporting cardiocirculatory disease diagnosis [1]. Clinical manifestations can be controlled through different therapeutics, coronary artery bypass graft surgery (CABG) being one of them. This surgery is effective in improving quality of life and it can extend the survival of patients with coronary artery disease. It is performed when lifetime probability is greater with the surgical treatment than with clinical treatment [2,3].

The CABG is a complex procedure, which implies physiological changes, and it imposes great organic stress. Its results are influenced by the clinical characteristics of patients and by aspects inherent to the surgical procedure and cardiopulmonary bypass (CPB) [4].

Patients undergoing sternotomy, associated with immobility in bed, pain and temporary dysfunction of diaphragm muscle, show pulmonary dysfunction in postoperative. In addition, typically they show advanced age, prior cardiac complications (unstable angina, triple vessels disease, previous revascularization, left ventricular dysfunction), and other related diseases [systemic arterial hypertension (SAH), diabetes mellitus (DM) and peripheral vascular disease], featuring a population of greater severity [5,6].

The main risk factors studied in preoperative are advanced

age, previous lung disease, smoking, poor nutritional status, impaired lung function, and associated comorbidities, that is, factors that lead to changes in the integrity of the respiratory system and may compromise respiratory mechanics and gas exchange [7]. In intraoperative factors, such as anesthetic induction, surgical incision, and the use of CPB can exacerbate respiratory impairment [5].

It is known that the appropriate control of the factors present in the preoperative period as well as the attempt to guarantee intraoperative stability, can ensure a good postoperative evolution by decreasing the occurrence of complications [8].

The objective of this study was to associate the pre-and intraoperative variables with postoperative complications of patients undergoing coronary artery bypass graft surgery.

METHODS

Adult patients of both sexes undergoing CABG were studied in two private hospitals in Bauru, SP, from November 2005 to March 2008. The research project was approved by the Ethics in Research Committee of Sacred Heart University of Bauru under the protocol number 16/07, in accordance with the Declaration of Helsinki. Patients were previously informed about the research and they signed the consent form after their acceptance.

Individuals with coronary insufficiency undergoing elective CABG were part of the sample, and their surgical access was by median sternotomy, with the use of cardiopulmonary bypass. Patients in *New York Heart Association* functional

class IV heart failure and *Canadian Cardiovascular Society* class IV angina did not participate in the study.

The study started with an interview with the patients the day before the surgery and the analysis of their respective medical records. All data collected were included in a detailed evaluation form containing personal data, diagnosis, risk factors for coronary artery disease (SAH, DM, dyslipidemia, smoking), functional classification of heart failure and angina severity, and related diseases.

The results of the following preoperative supplementary exams were recorded: creatinine, hemoglobin, hematocrit and coronary angiography. Information about the surgery, such as number of grafts, CPB duration, and mechanical ventilation was obtained.

Weaning from mechanical ventilation was performed in accordance with criteria for extubation adopted by the medical staff. From the first day after extubation, the patients began the sessions of physiotherapy, following the protocol adapted by the hospital physiotherapist staff, which consisted of lung reexpansion with breathing patterns, respiratory incentive, orthostatism, and deambulation once a day [9].

The following information was obtained regarding the postoperative period: amount of blood received, hospital stay and complications presented by the patient.

The variables of the preoperative, intraoperative, and postoperative periods were categorized to facilitate statistical analysis. Age was divided into four categories: 40-50 years, 50-60 years old, 60-70 years old and above 70 years old. Variables related to risk factors such as preoperative SAH, DM, dyslipidemia, and chronic obstructive pulmonary disease (COPD) as well as sex, acute myocardial infarction (AMI) and angioplasty variables were divided into mutually exclusive categories. Smoking was categorized as non-smokers, current smokers and former smokers. Heart failure and angina were distributed according to their functional class. For body mass index (BMI), individuals were classified as normal, overweight or obese. For arterial lesions, reporting of single, double or triple coronary lesions was considered. Hemoglobin and hematocrit values were considered normal according to age and sex. For creatinine values, references between 0.7 to 1.3 mg/dL for men and 0.6 to 1.2 mg/dL for women were used; values above the references were deemed increased. Cutoffs for the CPB time were: less than or equal to 120 minutes and greater than 120 minutes. Duration of mechanical ventilation (MV) was less than or equal to 12 hours or longer than 12 hours. The variable discharge was categorized as: up to 9th postoperative day (POD), 10th to 16th POD and above 17th POD.

The postoperative complications were divided into nine categories (uncomplicated, urinary tract infection, mental confusion, infection in surgical incision, difficulty walking, renal dysfunction, respiratory problems, dyspnea, and abnormal chest radiograph), generalized weakness, stroke, and respiratory

failure. The amount of blood received in the postoperative period was recorded as: up to four bags or above four bags.

Statistical analysis was performed using the statistical program Past (Paleontological Statistics software package for education and data analysis) version 2.15. The data are presented as average and standard deviation and absolute and relative frequencies. The preoperative and intraoperative variables were associated with postoperative complications by chi-square test with continuity correction for comparisons of proportion. When the frequencies were less than five the Fisher exact test was used. Associations of variables with more than three categories were analyzed using ANOVA. The significance level adopted was 5%.

RESULTS

Fifty-eight subjects were included in the study with a mean age of 62 ± 10 years old and the majority were male (67.2%). Patient characteristics are shown in Table 1.

In terms of heart failure classification, in accordance with the *New York Heart Association*, three (5.2%) patients were in class I, 37 (63.8%) in class II, and 16 (31%) in class III. Regarding angina severity, five patients (8.6%) were in class I, 35 (60.3%) in class II and 18 (31%) in class III, in accordance with the *Canadian Cardiovascular Society*.

Eighteen (31%) patients presented postoperative complications. The most frequent complication were: infection in the surgical incision in six patients, difficulties in deambulation in four patients, dyspnea in four patients, urinary infection in three patients, and generalized weakness in three patients.

Table 1. Patient characteristics

Variables	Values
Gender (male/female)	39 (67.2%) 19 (32.8%)
Age (years)	62±10
BMI (kg/m ²)	28±3.8
Smoking	
Smokers	14 (24.1%)
Ex-smokers	20 (34.5%)
Nonsmokers	24 (41.4%)
Myocardial infarction	39 (67.2%)
Angioplasty	11 (19%)
Coronary angiographies	
One-vessel	5 (8.6%)
Two-vessel	16 (27.6%)
Three-vessel	37 (63.8%)
Comorbidities	
SAH	43 (74.1%)
DM	16 (27.6%)
Dyslipidemia	37 (63.8%)
COPD	9 (15.5%)

Data expressed as mean \pm standard deviation or n (%). BMI: body mass index; COPD: chronic obstructive lung disease; DM: diabetes mellitus; SAH: systemic arterial hypertension

Cardiopulmonary bypass time was 102 ± 25 minutes and the MV time was 15 ± 4 hours, not including the ventilation time of a patient who needed reintubation and respiratory support.

Male patients had fewer complications than female patients (20.5% and 52.5%, respectively; $P=0.005$). These patients had one or more of the following complications: infection in the surgical incision, stroke, respiratory or urinary infection, renal dysfunction, difficulty in deambulation, dyspnea, generalized weakness and mental confusion.

Individuals with COPD remained hospitalized for a longer period of time ($P=0.019$). While 94% of the individuals without COPD, were discharged by the 10th PO, only 66.6% of the COPD patients were discharged in the same time period.

In 50% of the patients with elevated creatinine levels, complications such as renal dysfunction, infection in the surgical incision, mental confusion, and difficulty walking were observed, whereas only 27.1% of the patients with normal creatinine levels had complications ($P=0.049$).

In addition, there were complications in eight (50%) patients with DM, such as urinary tract infection, infection in the surgical incision, dyspnea, and generalized weakness; 32 patients without DM (23.8%) had complications ($P=0.032$).

As far as the number of grafts received, 25 patients received four grafts, 23 patients received three, six patients received two and four patients received five grafts. The medical records had no information as to what kind of grafts they were.

Postoperative complications were not associated with the presence of previous AMI, heart failure or severe angina, smoking, previous angioplasty, SAH presence, DM or dyslipidemia, hemoglobin and hematocrit levels, or CPB and mechanical ventilation times.

DISCUSSION

In this study with 58 patients, a predominance of males and a median age of 62 years old was observed, which is similar to other studies in terms of sex and age characterization associated with cardiovascular risk [10,11]. The median age of patients undergoing CABG has increased over the years, from 58.5 years old in the 1980s to 64.1 years old in the 1990s [12]. In this study, 27.6% of the patients were older than 70 years old.

Performing CABG in increasingly elderly individuals means more intense care due to the greater number of postoperative complications that occur in this age group, with a consequent increase in on-call time in the hospital. Other factors associated with advanced age can further increase the patient's hospital stay [6,13]. Parsonnet et al. [14] and Hannan et al. [15] found increased risk only in the age group over 70 and 80 years old, respectively. In our study, 56% of the patients over 70 years old presented one (44%) or more (12%) postoperative complications.

Tu et al. [16] evaluated postoperative hospital stay in the intensive care unit (ICU) and global postoperative hospital stay and they determined that postoperative hospital stay ≥ 6 days in the ICU and ≥ 17 days in the hospital would be extended linked to the presence of complications. Ducci et al. [17] found an average of 8 days of hospital stay in his study with patients undergoing CABG, a similar result to ours, in which 89.6% of the patients were discharged by the 9th postoperative day.

Guimarães et al. [18] reported that 45.5% of the patients showed postoperative complications, a higher frequency than our study in which 31% had one or more complications. The complications can be classified into pulmonary, renal, cardiac, neurological and infectious [19]. In our study, the infectious and pulmonary complications were observed more frequently.

Most studies include being female as a risk factor for complications and mortality in heart surgery. Women have higher comorbidity conditions such as congestive heart failure, Braunwald class IIIB and IIIC angina, as well as kidney failure, and, typically, they are subjected to surgery when they are older. In addition, inadequate or inappropriate approach to chest pain occurs more frequently in women, resulting in bias in the evaluation and delayed diagnosis and treatment [12,14,19,20]. These data corroborate with the present study in which women presented a higher frequency of one or more complications.

The incidence of complications in diabetic patients found in our study corroborates the findings of Ledur et al. [21] that showed the disadvantage of diabetics compared with patients without DM on the risk of any infection in post-CABG. Predisposition to diabetic inflammatory processes may occur due to an increase in pro-inflammatory markers and a decrease in inflammatory proteins [22].

Smoking is associated with postoperative pulmonary complications, especially increased mechanical ventilation time, pneumonia, infection, and slower healing [23]. The respiratory system of smokers is compromised, which hinders alveolar ventilation after extubation. Our results showed no statistically significant difference between smokers and nonsmokers.

The use of CPB is associated with postoperative bleeding, which can occur due to the increase in the use of clotting factors, hemodilution, hypothermia and, mainly, due to the inflammatory response. Besides CPB, other factors are associated with the need for blood transfusions, including: low body mass index, low levels of hematocrit and hemoglobin preoperatively, age over 74 years old and severe left ventricular dysfunction [24]. In our study, CPB time showed no statistically significant differences when associated with the amount of blood received postoperatively.

In terms of renal function, Higgins et al. [25] showed increased risk of postoperative mortality in patients with serum creatinine ≥ 1.9 mg/dl and moderate risk between 1.6

and 1.8 mg/dl. In this study, 50% of the patients with elevated creatinine showed increased postoperative complications.

The presence of dyslipidemia or SAH in preoperative was not significantly related to complications in our study. However, the presence of COPD, DM or renal dysfunction (increase in creatinine) were associated with increased complications, in accordance with literature data [12,14,19,22,25].

The literature reports, as well as the results of this study shows that the preoperative clinical condition of the patient is the main determining factor of surgical results. Clinical instability before surgery is the most important risk component for the results of the surgical procedure. Risk prediction based on a good pre-operative evaluation is essential to quantify the severity of the patient and to make it possible to plan for the care to be provided. These kind of care are associated with better intraoperative and clinical condition on the postoperative period of the patient.

CONCLUSION

In conclusion, this study shows that there is association between preoperative factors and postoperative complications in patients undergoing coronary artery bypass graft surgery.

Author's roles & responsibilities	
CG	Design and planning of the work, interpretation of the evidence, drafting and revision of the preliminary and final versions, and approved the final draft
SRB	Design and planning of the work, interpretation of the evidence, drafting and revision of the preliminary and final versions, and approved the final draft
BM	Interpretation of the evidence, drafting of the preliminary and final versions, and approved the final draft
CFR	Interpretation of the evidence, drafting of the preliminary and final versions, and approved the final draft
EAA	Interpretation of the evidence, drafting of the preliminary and final versions, and approved the final draft
RG	Drafting of the preliminary and final versions, and approved the final draft
MPO	Drafting of the preliminary and final versions, and approved the final draft
KO	Design and planning of the work, interpretation of the evidence, drafting and revision of the preliminary and final versions, and approved the final draft

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