Coronary Artery Bypass Grafting in Acute Myocardial Infarction. Analysis of Preoperative Predictors of Mortality

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Objective

To assess preoperative predictors of mortality in patients undergoing coronary artery bypass grafting (CABG) within the first 30 days of acute myocardial infarction (AMI).

Methods

Between March 1998 and July 2002, 753 AMI patients were consecutively and prospectively entered into a database, 135 (17.9%) of whom underwent isolated CABG and were enrolled in this study. The following prognostic factors were assessed by multivariate analysis: age, gender, diabetes, history of previous AMI, CABG or coronary angioplasty (PTCA), anterior infarct location, Q-wave AMI, the use of fibrinolytics, elapsed time from AMI to the procedure, and presence of complications in the preoperative period.

Results

Overall in-hospital mortality was 6.7%, ranging from 12.5% in patients with preoperative complications to 1.4% in those with no complications. Only history of previous angioplasty ($p = 0.037$) and cardiogenic shock ($p = 0.002$) showed a statistically significant correlation with postoperative mortality. The use of thrombolytics, on the other hand, in the initial management of AMI showed a negative correlation with mortality ($p = 0.035$).

Conclusion

CABG in the acute phase of MI is associated with distinct operative mortality, depending on the patient's preoperative clinical condition. Among those factors analyzed, preoperative cardiogenic shock and history of previous angioplasty were predictive of worse prognosis in this group of patients.

Key words

mortality, surgery, acute myocardial infarction.

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Received on 17/11/04 • Accepted on 12/08/05

Since the 1970s, studies have been made to determine the optimal timing of coronary artery bypass graft surgery (CABG) after acute myocardial infarction (AMI) with less operative risk[1-7]. However, there is no consensus in the literature regarding this point[6]. Some groups wait for up to 30 days after AMI before revascularization in an attempt to prevent potential complications that may arise during the recovery period following myocardial infarction[6].

A first, coronary artery bypass graft surgery (CABG) was used as recanalization and performed as early as possible after AMI in order to reduce infarction size, however with high surgical morbidity and mortality rates[1-4]. From the 1980s on, CABG has been less and less used as recanalization after AMI, because other techniques became available, such as fibrinolytic therapy and percutaneous procedures[8,9]. Thus, surgery in this phase is reserved for patients who failed to improve with the above recanalization techniques or evolved to persistent angina or hemodynamic instability[10]. In another group of patients, recanalization is successful; nevertheless, the patient has major residual coronary obstructions requiring surgical intervention[11]. In clinically stable patients, operative mortality rates range from 2% to 4%, very similar to those of patients who undergo elective revascularization[10,11]. However, in patients with clinical or mechanical complications, mortality rates rise to 6%-26%[12-14].

This study aims at analyzing preoperative risk factors predictive of mortality in patients who undergo CABG in the first 30 days following AMI.

Methods

Between March 1998 and July 2002, 753 patients diagnosed with AMI were admitted to the coronary care unit and entered, consecutively and prospectively, in a specific database. Of these, 145 (19.3%) underwent CABG during the acute and subacute phase of myocardial infarction.

Myocardial revascularization was an isolated procedure in 135 (93.1%) patients who made up the group analyzed in this study. Ten (6.9%) patients who underwent CABG with associated procedures (e. g., valve replacement or repair) or had mechanical complications secondary to AMI (e. g., interventricular septal rupture) were excluded.

The study group consisted of patients with one-, two-, or three-vessel disease greater than 70% luminal diameter, with preserved or impaired ventricular function. Patients' age at the time of surgery ranged from 29 to 94 (mean 62.3 ± 11.2), and 102 (75,6%) were males. Forty (29.6%) patients had type II diabetes mellitus, 32 (23.7%) had history of prior AMI, 11(8.1%) had already undergone myocardial revascularization previously and 9 (6.7%), coronary angioplasty.

With respect to AMI location, the anterior wall was involved in 46% of the patients, the inferior wall in 43%, and other areas, in 11%. Q-wave AMI was diagnosed in 86 (63.7%) of the patients. Thirty-nine (28.9%) were on fibrinolytic therapy prior to surgery, mostly streptokinase.

The following preoperative variables were evaluated as prognostics for myocardial revascularization during the acute phase of myocardial infarction: age, gender, history of diabetes mellitus, previous infarction, previous CABG or angioplasty (both prior to the AMI under study), Q-wave and non-Q-wave AMI, anterior wall infarction, use of fibrinolytics, time from AMI to CABG, presence of preoperative complications [recurrent ischemia, congestive heart failure (CHF), cardiogenic shock (CS), reinfarction, sustained ventricular tachycardia (SVT), and ventricular fibrillation (VF)]. Incidence of these complications is shown on Table 1. Although left ventricular ejection fraction (LVEF) was a major prognostic factor in patients undergoing CABG, this analysis chose to work specifically with clinical data, easily collected from any patient, even from those who undergo urgent or emergency CABG. Therefore, CHF and CS, widely known to show excellent correlation with ejection fraction, were included.

Table 1 – Incidence of preoperative complications

Preoperative complications	n (%)
Recurrent ischemia	45 (33.3%)
Heart failure	21 (15.6%)
Cardiogenic shock	12 (8.9%)
Reinfarction	9 (6.7%)
Sustained ventricular tachycardia	8 (5.9%)
Ventricular fibrillation	5 (3.7%)

Median time interval between AMI and CABG was 10.6 days, mean of 11.6 days (standard deviation of 6.4 days). An average of 3.0 grafts per patient were performed, 184 arterial (1.4 arterial graft/patient) and 219 venous grafts (1.6 venous graft/patient), denoting complete CABG. The left internal thoracic artery (LITA) was used in 117 (63.6%) patients; the right internal thoracic artery (RITA), in 32 (17.7%); the left radial artery, in 33 (17.9%); and other arterial grafts, in 2 (1.1%).

In regard to the revascularized area, the anterior wall was revascularized with 204 (50.6%) grafts, the lateral wall with 114 (28.3%), and the inferior wall, with 85 (21.1%).

Statistical analysis was performed using Systat software. Data were first assessed by univariate analysis, using Fisher's test and the chi-square test for categorical variables and the Mann-Whitney test for continuous variables. Prognostic factors were determined by multivariate analysis using a stepwise logistic regression model. P values <0.05 were considered statistically significant.

Results

There were 9 in-hospital deaths (6.7%). However, when preoperative clinical complications were grouped into a single variable, the number of deaths rose to 8 (12.5) in the group of patients presenting them. Conversely, only one (1.4%) death occurred among patients without preoperative clinical complications (odds ratio 10, p = 0.013, Figure 1).

In the univariate analysis, only the cardiogenic shock, ventricular fibrillation, and history of angioplasty variables correlated with mortality. The other variables showed no statistically significant correlation with mortality (Table 2).

Of the 12 patients with cardiogenic shock, 5 (41.7%) died after surgery (OR= 21.2; p< 0.001). There were 2 (40%) deaths among the 5 patients with preoperative ventricular fibrillation (OR = 11.7; p = 0.002) and 2 (22.2%) deaths among the 9 patients with history of angioplasty (OR = 4.8; p=0.053).

In the final model of multivariate analysis, only history of previous angioplasty (p = 0.037) and cardiogenic shock (p = 0.002) remained statistically significant with the death variable. On the other hand, the use of fibrinolytic agents to treat AMI on admission showed negative correlation with mortality (p = 0.035), thus corroborating the major role of recanalization in the acute phase of myocardial infarction.

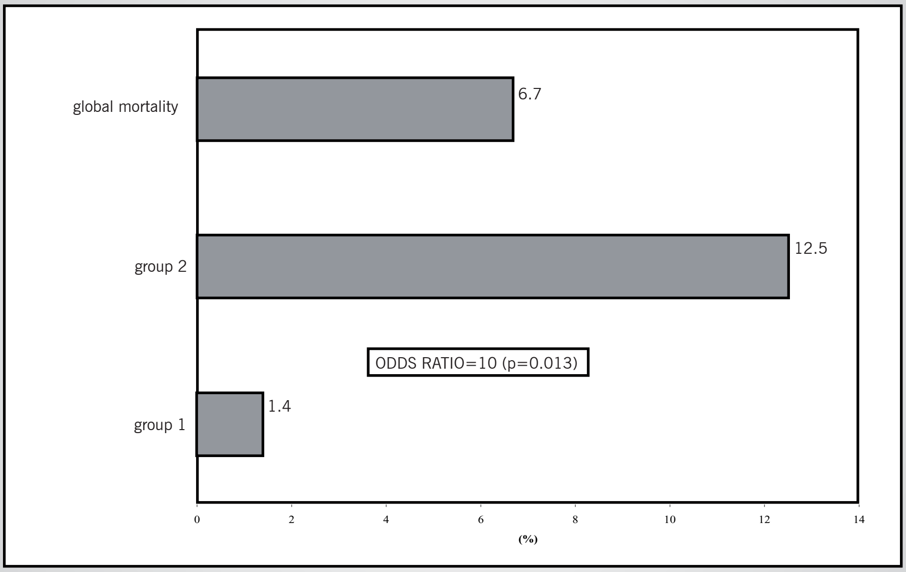

Fig. 1 - *Hospital mortality among AMI patients who underwent CABG. Group 1 (without preoperative clinical complications) and group 2 (with preoperative clinical complications; AMI - acute myocardial infarction; CABG - coronary artery bypass graft).*

Table 2 – Univariate analysis of preoperative factors

Preoperative prognostic factors	p
Age	p = 0.167
Gender	p = 0.872
Diabetes mellitus	p = 0.314
Previous angioplasty	p = 0.053
Previous revascularization	p = 0.737
Previous AMI	p = 0.482
Q-wave AMI	p = 0.363
Previous AMI	p = 0.926
Inferior AMI	p = 0.430
Use of fibrinolytic agent	p = 0.257
Interval between AMI and CABG	p = 0.379
Recurrent ischemia	p = 0.143
CHF	p = 0.128
Cardiogenic shock	p < 0.001
Sustained ventricular tachycardia	p = 0.495
Ventricular fibrillation	p = 0.002
Reinfarction	p = 0.407

AMI - acute myocardial infarction; CABG - coronary artery bypass graft; CHF - cardiac heart failure.

Discussion

Indication for CABG in acute myocardial infarction is still controversial, and there is no consensus in literature regarding the optimal timing of surgery[15-17]. Theoretically, there would be some advantage in waiting for the AMI to heal (4 to 6 weeks), allowing complete recovery of the stunned myocardium and preventing risk of myocardial damage after reperfusion, which may even lead to hemorrhagic infarction[15,18]. However, the risks associated with this waiting period must be weighed, such as recurrent ischemia, with possible reinfarction due to the lesions; infarct extension with ventricular remodeling, which can generate aneurysm; and significantly higher costs from prolonged hospital stay[15,17,19].

Some patients require urgent myocardial revascularization, such as those with mechanical complications associated with acute myocardial infarction[20] or patients with cardiogenic shock and left main coronary artery disease or three-vessel disease[21,22]. Yet, there are doubts regarding when to operate on patients who, despite their good clinical outcome following AMI, have multivessel disease or even isolated lesions of unique characteristics requiring CABG[23-25].

With regard to surgical aspects, CABG following AMI shows some particularities. Braxton et al. reported using 2.4 grafts per patient in the AMI group and 2.6 grafts per patient in the control group (without AMI); however, the left internal thoracic artery (LITA) was used in 43% of the patients operated on within 48hs, 72% of those operated on between 3 to 5 days, 92% of those operated on between 6 to 42 days, and 82% of the control patients[5]. Johanes et al., although describing as their purpose complete CABG and the use of LITA in all patients, placed LITA in 87% of the patients with AMI, compared with 97% of the elective patients (p = 0.008)[10]. Likewise, in our patients, the average number of grafts used was 3.0, reflecting the important role of complete revascularization in preventing complication, such as postoperative recurrent ischemia or reinfarction, which may compromise patients' outcome. Moreover, we have used LITA whenever possible (63.6%)[26,27], because its advantages are well established in the literature.

In 1994, Sintek et al published the results of 530 patients with AMI who, after fibrinolytic therapy and stratification, were referred for CABG. Of these, 23 patients were operated on within the first 24 hours of myocardial infarction, with 4.4% hospital mortality; 30 patients were operated on between 24 and 72 hours, with no deaths; 193 patients underwent surgery between 3 to 7 days, with 2.1% mortality; and 284 patients underwent surgery between 1 week to 1 month, with 1.4% mortality. Comparatively, 1,645 patients without previous AMI had an operative mortality of 1.9%. The number of grafts per patient was 2.9. The use of intra-aortic balloon was necessary in 6.7% of the patients with AMI and in only 2.6 of the patients in the control group[17].

Lee et al retrospectively evaluated 32,099 patients who underwent CABG after transmural AMI at 33 hospitals in New York State, USA. They concluded that CABG performed within 3 days after AMI may increase the risk of hospital mortality, regardless of other operative risk factors included in the multivariate analysis. Operative mortality varied according to different time intervals between AMI and surgery, and was 14.2%, 13.8%, 7.9%, 3.8%, 2.9%, and 2.7% for surgeries performed within less than 6 hours, 6 hours to 1 day, 1 to 3 days, 4 to 7 days, 7 to 14 days and 15 days or more, respectively. Therefore, these authors recommend that, in the absence of indication for emergency surgery, a three-day waiting period be observed before CABG, because after that mortality indices are similar[6]. Data from our study corroborate this recommendation, because median time interval between AMI and CABG was 10.6 days. Our experience can be divided into 3 phases that allowed us to note a trend towards earlier surgery. In the first patients, mean interval was 13.6 days; in the intermediate group, 12.3 days; and more recently, patients are being referred for surgery in 8.2 days.

Countless studies have been trying to identify which group of patients are at higher operative risk after AMI[9,10,11,16,22,26]. Data from the National Registry of Myocardial Infarction 2, which assessed 71,774 AMI patients who underwent CABG, point to the following variables as risk factors for operative mortality: female gender, Q-wave AMI, age > 65, history of CHF and diabetes mellitus, previous CABG, and Killip's classification of AMI[11].

Applebaum et al[28] analyzed 1,726 patients who underwent CABG, 406 of whom were operated on within 30 days of AMI, and found hospital mortality of 2.4%. In the subgroup of patients with history of recent AMI mortality rate was 6.7%, compared with 1.1% in the subgroup with no history of previous AMI. In the multivariate analysis, 3 factors were significantly associated with increased hospital mortality, namely, ejection fraction less than 30% (p<0.0001), preoperative cardiogenic shock (p = 0.0005), and age older than 70 (p=0,004). In the follow-up performed in 90% of the patients at a mean time of 35 ±21 months, 88% were alive at 3 years after surgery and 84% at 5 years. Thus, it has been concluded in this study that patients younger than 70 with ejection fraction greater than 30% and not in cardiogenic shock can be operated on at any time after AMI, without further risk[28]. As for ejection fraction, this variable was not included in our study; however, there is a clear correlation between low ejection fraction and patients' progression to cardiogenic shock. Age was not included as a categorical variable in our model, but rather as a continuous variable, and was not associated with mortality. In our analysis, cardiogenic shock was also a major predictor of mortality.

In the SHOCK trial, early CABG was studied in 302 patients with AMI complicated by cardiogenic shock; 152 were randomly assigned to emergency revascularization and 150, to medical stabilization. Revascularization was performed within 6 hours after randomization, either by cardiac surgery (57 patients) or hemodynamic procedure (75 patients). Overall mortality at 30 days did not differ significantly (p = 0.11) between the revascularization and medical therapy groups (56% and 46.7%, respectively). However, the six-month mortality rate was lower in the group that underwent revascularization than in the group that received medical therapy (50.3% vs. 63.1%, p = 0.027). It was concluded, therefore, that early revascularization should be strongly considered for patients with AMI complicated by cardiogenic shock[21].

Another aspect that must be emphasized here is that overall mortality in our study was 6.7%, identical to that observed by the Applebaum group[28]. Nonetheless, in a subgroup of patients with no preoperative medical complications, mortality rate was as low as 1.4%, comparable to or even lower than the mortality rate in elective surgeries.

Despite decades of experience, we have found studies showing increased mortality among patients operated on early after AMI[6,15,16] and others reporting the safety of CABG at any time after AMI[17,25,29,30]. In our study, no relation was found between mortality and time from AMI to CABG. In the multivariate analysis, the presence of cardiogenic shock and history of angioplasty determined the highest operative mortality. Actually, mortality is higher among patients who undergo angioplasty and CABG during the same hospitalization; however, a clear relationship between history of previous angioplasty and operative mortality is yet to be established, and other studies are needed to clarify this issue[31]. There may be variables associated with history of previous angioplasty, such as more diffuse coronary disease, worse left ventricular function, among others which were not included in our analysis and may confound this conclusion.

Despite the fear of increased bleeding during surgery and in the postoperative period of patients who received pharmacological fibrinolysis, some groups have demonstrated that CABG may be performed early on in these patients with low morbidity and mortality rates[32]. As was shown in our series, the use of fibrinolytics was beneficial, as it was a protective factor during surgery, because recanalization in the acute phase provides more long-term clinical stability.

We concluded, therefore, that CABG in the acute phase of AMI is associated with an acceptable operative mortality rate. Among the factors analyzed, the presence of preoperative cardiogenic shock and history of angiography determined poorer prognosis in this group of patients.

Potential Conflict of Interest

No potentil conflict of interest relevant to this article was reported.

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