Impact of Renal Failure on In-hospital Outcomes after Coronary Artery Bypass Surgery

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Abstract

Background: Chronic kidney disease (CKD) is a predictor of increased mortality in patients undergoing coronary artery bypass surgery (CABG).

Objective: To evaluate the characteristics and predictors of increased mortality in the CKD population submitted to CABG. To compare in-hospital outcomes between patients with and without CKD, and with and without development of acute renal failure (ARF).

Methods: Retrospective analysis of a prospective database of all isolated CABG performed in a single public tertiary hospital from 1999 to 2007. CKD was considered when creatinine > 1.5 mg/dl. Clinical characteristics, mortality and post-operative complications were evaluated according to renal function.

Results: Of 3,890 patients, 362 (9.3%) had CKD. This population was older, presented grater prevalence of hypertension, left ventricular dysfunction, previous stroke, peripheral vascular disease and three-vessel disease. In-hospital outcomes revealed greater incidence of stroke (5.5% *vs* 2.1%), atrial fibrillation (16 *vs* 8.3%), low cardiac ouput syndrome (14.4% *vs* 8.5%), longer stay in intensive care unit (4.04 *vs* 2.83 days), and greater mortality (10.5% *vs* 3.8%). Logistic regression: female gender, smoking, diabetes and peripheral vascular disease were associated with higher in-hospital mortality within the CKD group. Patients who did not develop post-operative ARF presented 3.5% mortality; non-dialytic ARF: 35.4%; dialytic ARF: 66.7% mortality. Mortality was directly related to the stage of CKD, according to glomerular filtration rate.

Conclusion: CKD patients submitted to CABG represent a high risk population, with increased incidence of complications and mortality. Post-operative ARF is a strong in-hospital mortality predictor. Glomerular filtration rate was inversely related to mortality. (Arq Bras Cardiol 2011; 97(3) : 249-253)

Keywords: Renal insufficiency, chronic; myocardial revascularization / mortality; morbidity; prognostic; lenght of stay; intensive care units.

Introduction

Chronic kidney disease (CKD) is a risk marker in patients with coronary artery disease (CAD)[1]. In patients undergoing coronary artery bypass grafting (CABG), CKD is associated with longer hospitalization and higher rates of hospital morbidity and mortality[2-4]. CKD, even from mild to moderate, implies an increase in mortality after CABG. Prognosis is even more reserved in patients with chronic kidney disease in the terminal phase[5]. Moreover, the need for dialysis procedures in the postoperative period is associated with significant elevation of hospital mortality, and its incidence is higher in CKD patients prior to cardiac surgery[4,6,7].

Patients with CKD are older, have a higher prevalence of diabetes and hypertension, and these factors are also associated with higher operative mortality. Despite this association, it is believed that chronic kidney disease is an independent marker of mortality in the long term[8]. The scores of surgical risk usually use CKD as a marker of increased surgical risk[9-11].

Although renal failure is a known major risk factor in patients undergoing CABG, the characteristics of patients with CKD are poorly known, as well as factors associated with increased morbidity and mortality in this specific group of patients.

Objective

This study aimed to evaluate the impact of primary chronic renal disease in morbidity (length of stay in the ICU, atrial fibrillation, low cardiac output syndrome and cerebrovascular accident) and hospital mortality after CABG and to identify factors associated with increased hospital mortality in the group with CKD. The secondary objectives were to assess the effect of acute renal failure after surgery on hospital mortality; analyze the relationship between hemoglobin and creatinine levels preoperatively; evaluate the importance of using the glomerular filtration rate calculated by the Cockcroft-Gault formula[12], defining the mortality found for each class of CKD.

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Methods

We performed a retrospective analysis of a database collected prospectively from January 1, 1999 to December 31, 2007, of all isolated CABGs in a tertiary cardiac education institution. Surgeries with associated procedures, such as prostheses and valvuloplasty, correction of aneurysms, and carotid endarterectomy were excluded. This study was approved by the local ethics and research committee.

Hospital operative mortality as defined as the one occurring within 30 days from the date of surgery or during hospitalization, regardless of the time elapsed since the operation[13]. We evaluated the clinical, laboratory, hemodynamic, operative and postoperative data.

CKD was considered the presence of preoperative serum creatinine > 1.5 mg/dl; ARF was considered high postoperative plasma creatinine ≥ 50% compared to baseline, or the need for dialysis postoperatively in patients who failed to perform it before the CABG.

We used the preoperative risk model European System for Cardiac Operative Risk Evaluation (EuroSCORE)[11] to calculate the risk of each patient.

Was also calculated creatinine clearance by the Cockcroft-Gault formula[12] for all patients.

For comparisons of categorical variables we used the chi-square test, and for continuous variables, Student *t* test. p values < 0.05 were considered statistically significant. Logistic regression models were used considering mortality as the dependent variable[13].

We compared non-CKD and CKD groups to their baseline preoperative clinical characteristics, length of stay in days in the Intensive Care Unit, and the occurrence of complications (atrial fibrillation, low cardiac output syndrome and cerebrovascular accident) and in-hospital death during postoperative evolution.

In the CKD group, we analyzed the correlation between the values of creatinine and serum hemoglobin on the earliest date of surgery, with a maximum interval of 30 days.

ROC curves were constructed for numerical variables referring to the measurement of renal function and serum hemoglobin, compared with mortality, in order to determine the level considered as cutoff points for markers of hospital mortality.

Results

Out of the 3,890 patients undergoing isolated CABG in the period, 362 (9.3%) had CKD. Table 1 describes the baseline characteristics of each group. Patients with CKD are a higher risk group, showing a significantly higher EuroSCORE compared with the group without CKD. The highest score was not justified only by the presence of CKD.

Table 2 shows the highest rates of complications of the CKD group.

In order to identify factors related to death in the CKD group, we used logistic regression analysis (Table 3). Female sex, smoking, diabetes, peripheral vascular disease and/or carotid artery were associated with increased mortality.

Table 1 - Populational characteristics of individuals undergoing coronary artery bypass grafting

	CKD group *	Non-CKD group	p value
Number of patients	362	3.528	
Average age (years)	68	62	<0.001
Female sex	20.7%	34.3%	<0.001
Hypertension	86.7%	79.4%	<0.001
Diabetes	40.6%	37.5%	0.245
Smoking	15.2%	20.3%	0.047
Previous myocardial infarction	49.4%	47.4%	0.468
Previous cerebrovascular accident	6.4%	3.2%	0.002
Dyslipidemia	65.7%	73.8%	0.002
EF < 56%	50.3%	33.3%	<0.001
Peripheral vascular disease/carotid artery disease	25.4%	9.8%	<0.001
Triple vessel coronary artery disease	59.4%	51.4%	<0.001
Lesion in left main coronary artery	18.2%	15.7%	0.12
EuroSCORE (50th percentile)	8.0	4.0	<0.001

**CKD - chronic kidney disease.*

Table 2 - Occurrence of events (complications and death) in postoperative in-hospital evolution

	CKD group *	Non-CKD group	p value
Time in ICU† (days)	4.04	2.83	<0.001
Atrial fibrillation	16	8.3	<0.001
Low cardiac output syndrome	14.4	8.5	<0.001
Cerebrovascular accident	5.50%	2.10%	0.001
Death	10.50%	3.80%	<0.001

**CKD - chronic kidney disease. †ICU - intensive care unit.*

The development of acute renal failure (ARF) resulted in a significant increase in mortality by 3.5% in the group who did not develop ARF compared to 35.4% in the group that developed ARF not requiring dialysis postoperatively and 66.7% in the ARF group that required dialysis therapy (p = 0.001).

Lower levels of hemoglobin after surgery correlated with higher severity of renal dysfunction, as measured by serum creatinine (Rho correlation = -0.368, p < 0.001). In the CKD group, mean creatinine was 2.1 mg/dl (± 0.6), and mean hemoglobin level was 12.3 mg/dl (± 1.9 mg/dl).

When renal dysfunction is measured by the Cockcroft-Gault formula[12] (Table 4) to calculate the glomerular filtration rate,

Table 3 - Factors associated with postoperative mortality among patients with chronic kidney disease

	OR*	CI 95%†	p
Female sex	2.79	1.23 – 6.33	0.014
Hypertension	1.99	0.666 – 5.94	0.218
Diabetes	7.19	1.32 – 39.08	0.022
Smoking	2.91	1.31 – 8.76	0.047
Previous myocardial infarction	3.93	0.704 – 22.03	0.119
Previous cerebrovascular accident	1.03	0.985 – 1.08	0.193
Dyslipidemia	1.08	0.511 – 2.31	0.827
Left ventricular dysfunction (ventriculography)	0.713	0.343 – 1.48	0.366
Peripheral vascular disease/ carotid artery disease	3.56	1.64 – 7.75	0.009
Triple vessel coronary artery disease	0.694	0.244 – 1.97	0.494
Lesion in left main coronary artery	0.997	0.373 – 2.66	0.995

**OR - odds ratio; CI† 95% - confidence interval on 95th percentile.*

Table 4 - Classification of renal function and in-hospital mortality

	Renal failure and mortality			
Class of renal failure	1 and 2	3	4	5
Total patients	21 (7.9%)	186 (69.9%)	47 (17.7%)	12 (4.5%)
Mortality	4.8%	18.8%	31.9%	33.3%

we found a higher prevalence of Class III renal dysfunction, and increased mortality with increasing CKD class[14].

It was not possible to detect cutoff values of serum creatinine or creatinine clearance by ROC analysis from which there was significant increase in the death outcome.

Discussion

This analysis of 3,890 patients undergoing CABG over six years (1999-2007) found 362 (9.3%) patients with CKD, with higher prevalence of males, older age, higher prevalence of hypertension, previous cerebrovascular accident, peripheral arterial disease, triple vessel coronary artery disease and left ventricular dysfunction, and hence a higher EuroSCORE.

Patients with CKD had higher rates of complications and mortality, and in this group, after adjusting for risk factors, correlated with higher female mortality, smoking, diabetes and peripheral arterial disease and/or carotid artery disease. Acute renal failure in the postoperative period was associated with a significant increase in mortality, especially when dialysis was needed.

In our sample, we found a prevalence of CKD of 9.3% similar to that described by Zaker et al[15], of 10.4%. We have set the value above 1.5 mg/dl as CKD. Other authors define values above 1.2 mg/dl, as used by Jyrala et al[16], who have found increased mortality from this value of creatinine before the surgery and other authors set values of 2.26 mg/dl (< 200 micromol/l)[15] as a cut-off value for DRC, which is the same used by the EuroSCORE[11]. Values set by glomerular filtration rate are more reliable for evaluation of renal function, being used by some authors when smaller than 60 ml/min[17].

Hemoglobin and creatinine levels after surgery showed an inverse relationship, showing a higher incidence of anemia according to worsened renal function, but the identification of a cutoff point for increased mortality by the ROC curve was not possible. This may explain why there is a systematic correction of anemia before and during surgery, usually by blood transfusion, making it difficult to measure anemia effectively; consequently, anemia was not associated with mortality.

The greater number of comorbidities in the CKD group is a similar finding to previous studies, compared to information from large databases, such as the database of the STS (Society of Thoracic Surgeons National Adult Cardiac)[3] and the database of the state of California[18]. Patients with CKD have a higher prevalence of risk factors associated with increased operative mortality defined by Jones et al[9] such as advanced age, female sex, peripheral arterial disease, left ventricular dysfunction. The EuroSCORE[19] includes renal failure as a risk factor for mortality, as well as age, female sex, peripheral arterial disease and left ventricular dysfunction. The STS database points to severe renal dysfunction as an important marker of hospital mortality, involving severe CKD and dependence on dialysis with a risk ratio from 2.9 to 3.8 on mortality[3].

In this study, a significant number of patients was evaluated, revealing a mortality of 3.8% in the group without CKD and a significantly higher mortality of 10.5% ($p < 0.001$) in patients with CKD. Piegas et al[20] describe a national mortality rate for CABG of 6.22%, but these data refer to total revascularization, without exclusion of surgeries with associated procedures, which interfere in the analysis of mortality.

The development of ARF in the postoperative period was associated with significant increases in mortality, especially when hemodialysis was necessary. Even small changes in renal function postoperatively are associated with significant elevations in mortality, according to studies by Litmathe et al[21] and Machado et al[22]. The cardiopulmonary bypass (CPB) was higher in the CKD group, probably related to a greater number of vessels involved. This greater time was identified by logistic regression analysis related to death. Diez et al[23] associated with a shorter duration of CPB to a smaller rate of occurrence of renal failure immediately after CABG. In our sample there were few patients operated without CPB, thus this factor was not analyzed. Di Mauro et al[24] evaluated CABG with and without CPB in patients with CKD, defined as creatinine > 1.5 mg/dl, and found no differences between the different strategies with respect to worsening renal function.

Until recently, most studies have used only creatinine to define CKD. The Brazilian Society of Nephrology[14] has set a five-level classification for renal failure, based on the glomerular filtration rate (GFR). According to these findings, there was a higher incidence of class III renal failure, and mortality progressively higher according to worsening renal function was found. Swart et al[25] found a correlation between GFR and lower risk of developing acute renal failure after

surgery, as well as Moore et al[26], who found also a correlation of GFR with time of hospitalization. Lopes et al[27], in turn, followed, for five years, patients with multivessel coronary disease under various therapies, and described a significantly higher mortality rate in the group with moderate renal impairment, compared with mild renal dysfunction and normal renal function according to the glomerular filtration rate[27]. Our study also demonstrated this inverse association between GFR and mortality.

Conclusions

Patients with CKD who underwent CABG constitute a higher risk population, evolving postoperatively with higher rates of complications and in-hospital mortality. In this group, female sex, smoking, diabetes and peripheral vascular disease and/or carotid artery disease were associated with higher mortality after surgery. The development of ARF in the postoperative period was associated with significant increases in mortality, especially when hemodialysis was necessary. The severity of anemia was directly related to the severity of renal dysfunction. When renal dysfunction was calculated by the glomerular filtration rate (Cockcroft-Gault formula), we found a hospital mortality progressively higher according to the worsening of renal function.

Potential Conflict of Interest

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

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Study Association

This study is not associated with any post-graduation program.

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