Is Renal Dysfunction a Risk Factor in Patients Undergoing Cardiac Surgery?: Mansoura Cardio – Thoracic Unit Experience

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Citation

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Abstract

Objective: To evaluate the effects of preoperative renal dysfunction on the outcome of the patients after cardiac surgery.

Methods: From January 2002 to march 2005, cardiac surgery (coronary artery bypass grafting or valve replacement) was performed in 30 patients with preoperative renal dysfunction (creatinine > 2.0mg/dl) and in 220 patients without renal dysfunction. Hospital outcomes were compared between propensity-matched pairs of 30 patients with renal dysfunction (Renal group) and without renal dysfunction (Control group).

Results: In the matched pairs, the early postoperative clinical results showed patients in the renal group were more likely to develop postoperative renal failure (p=<0.0001). The ventilatory support time, the intensive care and hospital stay were significantly higher in the renal group. The ventilatory support time was approximately three folds that for patients with renal dysfunction as for patients without (p=<0.0001). The mean length of stay in critical care units and hospital wards were approximately twice that for patients with renal dysfunction as for patients without (p=<0.01). The hospital mortality was higher in the renal group than the control group (10% vs. 3%, p=0.01, respectively).

Conclusion: Renal dysfunction increases the morbidity and mortality in patients undergoing cardiac surgery. It is associated with longer ventilation time, intensive care unit and hospital stay. However, surgery in this patient population can be performed with acceptable morbidity and mortality rates compared to general patient population. A careful perioperative management and proper choice of therapeutic strategies may be useful for improvement of the outcome.

INTRODUCTION

Preoperative renal dysfunction is an important risk factor that influences surgical morbidity and mortality[1,2]. Previous studies reported associations between preoperative renal dysfunction and poorer outcomes after cardiac surgery especially coronary artery bypass grafting (CABG) [2,3,4,5,6,7,8,9,10,11,12,13,14] and found that the morbidity was 2-3 times higher than a patient without renal failure.

The purpose of this retrospective study was to determine the incidence of the early postoperative renal failure, the perioperative predictors of renal failure, and hospital morbidity and mortality in patients with renal dysfunction undergoing cardiac surgery in our Mansoura Cardiothoracic Unit.

PATIENTS AND METHODS

From January 2002 to March 2005, cardiac surgery (coronary artery bypass grafting (CABG) or valve replacement and combined procedures) was performed in 30 patients with preoperative renal dysfunction (Creatinine >2.0mg/dl) and in 220 patients without renal dysfunction, at the Cardiothoracic Unit and Mansoura International Hospital, Mansoura Faculty of Medicine.

DATA SOURCE

Clinical, operative and outcome data were collected retrospectively in a computerized database for 250 patients undergoing cardiac surgery (CABG or valve replacement and combined procedures). Thirty patients had renal dysfunction with preoperative serum creatinine ≥ 2.0mg/dl.

Hospital outcomes were compared between propensity-matched pairs of 30 patients with renal impairment (Renal group) and 30 patients without renal impairment as a control (Control group). Of the renal group, three patients (10%) were dialysis-dependant.

Both groups (Renal/Control) were then matched on 12 prognostic preoperative variables: (age, sex, LV function, NYHA class, previous cardiac surgery, standard cardiac risk factors, preoperative stroke or TIA, Timing of surgery, peripheral vascular disease (PVD), CHF, shock, and syncope) [Table (1)].

Figure 1

Table 1: Preoperative variables in the studied groups: Data are presented as % or mean±SD.

	Control Group (n=30)	*Renal Group (n=30)*
1. Demographic data		
Age (years)	42±15	48±17
Sex (% of female)	18%	19%
Body surface area	1.85±0.23 m²	1.9±0.2 m²
2. Standard Risk Factors:		
Diabetes Mellitus	43%	40%
Hypertension	50%	53%
Hypercholesterolemia	33%	30%
Preoperative MI	13%	16%
Preoperative Angina	66%	63%
PVD [Peripheral Vascular Disease]	43%	46%
3. NYHA functional class:		
I	6%	3%
II	6%	6 %
III	30%	33%
IV	58%	58%
4. Previous cardiac surgery	13%	10%
5. Preoperative stroke or TIA	20%	17%
6. CHF	73%	76%
7. Infective endocarditis	13%	16%
8. Timing of surgery		
Elective	87%	84%
Urgent/emergency	13%	16%

* $P < 0.05$ Significant when compared with the control group

Preoperative evaluation of all patients concerning medical history, clinical examination including ECG and chest x–ray, complete laboratory investigations and Echo Doppler evaluation of the heart and valves, coronary angiography were done.

After arrival in the preoperative area, patients were premedicated with midazolam 0.03 $mg.Kg^{-1}$, Fentanyl 1 $\mu g.Kg^{-1}$ via an intravenous catheter. Under local lidoceine 1% anesthesia, an arterial catheter (20 G) was placed to continuously record blood pressure changes and pulmonary artery catheter was inserted via the right internal jugular or subclavian veins for hemodynamic measurements. Cardiac output was measured using the thermodilution technique, by the mean value of six successive injections of 10 ml dextrose 5% at room temperature. All other standard anesthesia safety monitoring was rigorously adhered to, including ECG, pulse oximetry and capnography.

Anesthesia was induced by slow i.v. administration of fentanyl 20 – 30 $\mu g.Kg^{-1}$, propofol 1 – 2.5 $mg.Kg^{-1}$ and 0.6 $mg.Kg^{-1}$ atracurium to provide neuromuscular blockade and facilitate tracheal intubation. With loss of consciousness, positive pressure ventilation was started via a face mask at a rate of 12 – 15 breaths per minute. Patients were mechanically ventilated with 100% o2 and end – tidal CO2 was monitored and maintained between 35 – 40 mmHg. Anesthesia was maintained with isoflurane 0.2 – 0.8 %, propofol 2 – 4 $mg.Kg^{-1}.hour^{-1}$ and incremental doses of fentanyl and atracurium to maintain muscle relaxation. During all procedures, heart rate, rhythm, and computerized ST segment analysis were monitored on ECG monitor, pulse oximetry for O2 saturation measurements. Transesophageal echo Doppler probe was also inserted for assessment of cardiac motions and functions. A urinary catheter was placed to monitor urine output and rectal and nasopharyngeal temperatures were continuously monitored.

OPERATIVE TECHNIQUE

The conduct of the operation was similar in all patients. Following median sternotomy and heparinization, cardiopulmonary bypass was established with two caval cannulae and an ascending aortic cannula.

During bypass, the hematocrit was maintained between 20% and 25%, pump flow rates between 2.0 and 2.5 L/min per square meter, and mean arterial pressure above 50 mmHg using either sodium nitroprusside or phenylephrine hydrochloride as required. In elderly patients, the mean arterial pressure was maintained above 70 mmHg in an attempt to improve cerebral perfusion.

Blood cardioplegic solution was used in all patients. Blood cardioplegic solution was delivered either in an anterograde mannered via the aortic root till arrest started, then separately inside each coronary ostium.

An intra-aortic balloon pump (Data scope Corporation) was inserted percutaneously in patients who had difficulty in weaning from cardiopulmonary bypass or in whom inadequate cardiac performance was developed in the intensive care unit. Patients with less severe hemodynamic compromise received inotropic medication.

POSTOPERATIVE VARIABLES MEASURED

Postoperative low cardiac output syndrome (LOS) was diagnosed if a patient required either intra-aortic balloon pump or inotropic support for greater than 30 minutes in the intensive care unit to maintain a systolic blood pressure greater than 90 mm Hg and a cardiac index greater than 2.2 L/ minute per square meter despite an adequate preload and correction of any existing electrolyte disturbances. In patients who received an intra-aortic balloon pump prior to surgery for either ischemic chest pain or hemodynamic compromise, the diagnosis of LOS was made if, in addition to intra-aortic balloon pump, inotropic medication was also required.

Perioperative myocardial infarction was documented when a new Q wave was found on the postoperative ECG. A perioperative myocardial infarction was also diagnosed with the presence of a new left bundle branch block, loss of R wave progression, or new ST and T wave changes if accompanied by a rise in the level of Troponin.

Postoperative renal insufficiency was diagnosed if the serum creatinine rose above 2.0mg/dl at any time during the hospital admission. Postoperative renal failure was documented if the patient required CVVHD, peritoneal or hemodialysis. Hemodialysis during CBP was not considered as a renal failure.

Cerbrovascular stroke was defined as focal brain lesion confirmed with clinical findings and / or computed tomography scan.

Hospital mortality was defined as any death that occurred within 30 days of the operation or during the same hospital admission.

STATISTICAL ANALYSIS

Data were collected and managed in Microsoft Access database. All statistical analyses were performed using the SAS (Version 8.2) software for Windows. Univariate analysis of the data was performed using $?^2$ analysis or Fischer's exact test where appropriate for categorical variables. Analysis of continuous variables was carried out by unpaired Student's t test.

Variables that had a univariate p value of <0.25 or those judged to be clinically important were submitted into a logistic regression model by stepwise selection. Multivariate logistic regression methods were used to calculate risk-adjusted mortality and calculate factor-adjusted odd ratio.

Model discrimination was evaluated by the area under the receiver-operator-characteristic (ROC) curve and calibration was assessed with the Homer-Lemeshow goodness-of-fit statistic. For goodness of fit, the null hypothesis is that the model fits the data. Therefore, an insignificant p value is desired because a p-value of less than .05 would indicate a poor fit between predicted and observed results. All continuous variables are expressed as mean±SD. Statistical significance was assumed if $p < 0.05$.

RESULTS

Age, sex, and body surface area (BSA) showed no significant changes between the studied groups (control and renal groups). Also, both groups showed no significant changes in the preoperative characteristics (Table 1).

OPERATIVE DATA

Table (2) summarizes the operative data for both groups and showed no statistically significant difference.

Figure 2

Table 2: Operative Data: Data are presented as (%) or mean ± SD.

	Control Group (n=30)	*Renal Group (n=30)*
X-clamp time (minutes)	72±26	76±32
CPB Time (minutes)	102±46	108±45
CABG	40%	47%
Mitral valve replacement	27%	23%
Aortic valve replacement	20%	20%
Combined procedures	13%	10%
Operation Time (minutes)	200±55	206±68

* $P < 0.05$ Significant when compared with the control group

CLINICAL OUTCOME

Table (3) shows the results of surgery in both renal and control group. There was no significant difference between both groups regarding the perioperative myocardial

infarction, the incidence of Low cardiac output syndrome, stroke and the incidence of re-exploration for bleeding.

Figure 3

Table 3: Clinical outcome: Data are presented as (%) or mean ± SD.

	Control group (n=30)	Renal group (n=30)	P value
Perioperative MI	3%	3%	0.67
Low Cardiac Output Syndrome	7%	10%	0.8
Stroke	3%	3%	0.77
Re operation for bleeding	13%	10%	0.8
Postoperative renal failure	3%	17%	<0.0001*
Ventilation hours	9±4.8	25±7	<0.0001*
ICU stay (days)	4±1.9	7.1±2.9	0.01*
Hospital stay (Days)	10±4.6	21±9.8	0.01*
Hospital mortality	3%	10%	0.01*

* P < 0.05 Significant when compared with the control group

However, patients in the renal group were more likely to develop postoperative renal failure (p=<0.0001). The ventilatory support time and the intensive care stay were significantly higher in the renal group (Table 3). The ventilatory support time was approximately three times as long for patients with renal dysfunction as for patients without. The mean length of stay in critical care units and hospital wards were approximately twice as long for patients with renal dysfunction as for patients without. In the renal group; three patients died compared to only one patient in the control group (Table 3). Multivariate analysis showed that renal dysfunction was the second most important predictor of operative mortality (OR=3.5) after timing of surgery (OR = 5.5).

DISCUSSION

Our study shows that patients with preoperative renal dysfunction undergoing cardiac surgery are at higher risk for prolonged intensive care unit and hospital stays, and significant increases in mortality. Previous studies have been found that patients with renal insufficiency were associated with poor outcome following the cardiac surgery [2,3,4,5,6,7,8,9,10,11,12,13,14]. It is likelihood due to preoperative risk factors as elderly, diabetes mellitus, hypertension, peripheral vascular diseases and left ventricular dysfunction[2, 13]

In the present study, the preoperative risk factors are cross matched between the control group and the renal insufficiency group as regard the age, gender, body mass index, presence of diabetes mellitus, hypertension and peripheral vascular diseases, left ventricular dysfunction and the incidence of urgent operation. Also, the intraoperative risk factors are cross matched between both groups as regard aortic cross clamp, total cardiopulmonary bypass, and operative times. The postoperative risk factors for renal dysfunction are also cross matched as regard low cardiac output, myocardial infraction, hemorrhage and stroke. In addition, no therapies with potentially nephrotoxic medication (such as aminoglycosides antibiotics, nonsteroidal anti-inflammatory drugs or angiotensin-converting enzyme inhibitors) were used before, during and after surgery. In spite of the similarity of the preoperative, intraoperative and postoperative risk factors between both groups, patients with preoperative renal impairment was associated with a significantly increased morbidity in comparison with the control group as regard the postoperative renal failure, postoperative ventilation, ICU and hospital stay. This is in accordance previous studies following CABAG [6,13]and valve replacement surgery[14].

In the present study, the postoperative renal failure was significantly greater in the renal group. This is in accordance with previous studies [6,7,8,9,10,11,12,13,14]. This can be explained by the lack of increase in the glomerural filtration rate and the associated depression of renal function reserve and reduced numbers of functioning nephrons in the early postoperative period in patients with normal renal function [13]. In patients with preoperative renal insufficiency, it is likely that the renal function reserve is substantially more reduced than in patients with normal renal function in early postoperative period results in poor outcomes after cardiac surgery.

In this study, the development of postoperative acute renal failure in patients with preoperative renal insufficiency was associated with poor outcome after cardiac surgery. It was associated with a greater morbidity and mortality. This in accordance with previous studies [17,18]. They found that the development of acute renal failure was accompanied with a marked increase in the perioperative mortality[17,18].

The hospital mortality in this study was higher in the renal group than in the control group (10%, 3% respectively). This in accordance with Samuels et al, 1996[12] and Hayashida et al,2001[13]. Also, Yamamura et al, 2000, found that serum creatinine level greater than 1.6 $mg.dl^{-1}$ is the most important predictor of in hospital mortality after CABG surgery in

patients aged 70 years and over[19].

In this study, multivariate analysis showed that renal dysfunction was the second most important predictor of operative mortality (OR=3.5) after timing of surgery (OR = 5.5). In addition, Hayashida et al, 2001[13], found that renal dysfunction was the second important predictor of total mortality after poor left ventricular function.

In conclusion, preoperative renal dysfunction increases the morbidity and mortality in patients undergoing cardiac surgery. Renal dysfunction and timing of surgery were independent predictors of the clinical outcome after cardiac surgery (CABG or valve replacement and combined procedures). A careful perioperative management and the proper choice of therapeutic strategies may be useful for improvement of the outcome. Our data are limited to the early postoperative hospitalization stay, the effect of cardiac surgery in patients with preoperative renal dysfunction on long term outcome need further investigations.

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