Aortocoronary Bypass Grafting In Patients Over 75 Years: Incidence, Outcome And Risk Analysis Of Postoperative Renal Failure

M Meco, P Panisi, G Franciosi, M Babbini, A Caratti, B Khlat, S Cirri

INTRODUCTION

The number of elderly patients undergoing cardiac surgery is continuously increasing. This carries new problems linked to surgical intervention. For this subset of patients total mortality rates are currently acceptable, but the incidence of postoperative complications remains high. The aim of this study was to evaluate the preoperative, operative and postoperative risk factors for the onset of post-operative acute renal insufficiency, in patients 75 years of age and older undergoing elective intervention for coronary revascularization. In these patients, it is often difficult to quantify the preoperative surgical risk.

A risk analysis of post-operative renal insufficiency in this specific subset of patients has never been carried out. The operative strategy for these patients needs careful planning since they must be considered at high operative risk either for mortality or for morbidity. From a review of the international literature, many authors are favourable to consider these patients ideal subjects for revascularization without cardiopulmonary bypass. Aim of this paper is to help in placing indication to the intervention In order to choose the best operative option.

MATERIAL AND METHODS

We retrospectively analysed 154 consecutive patients 75 years of age and older operated on electively for CABG in our Institution from January 1999 to January 2000. In our analysis, we have defined post-operative renal failure as the condition in which patients had an increase of serum creatinine levels 1.5 fold basal value and urinary output less than 1 ml/kg/h.

Management of renal failure has entailed the following protocol: Hydration with crystalloids solutions to obtain optimal vascular filling, intravenous inotropic support to correct inadequate cardiac index, immediate beginning of...
total parenteral nutrition, intravenous Dopamine infusion (3-5 µg/ kg/ min) and intravenous diuretics with boluses of Furosemide up to 0.5 mg/ kg, then, followed by continuous e.v. infusion (1mg/ kg / h.) if no urine output could be detected.

Failure to restore adequate urinary output warranted immediate hemodialysis (CVVHD).

All patients were operated on in normothermia and myocardial protection was achieved with antegrade warm blood cardioplegia.

Patients considered at high operative risk received a pulmonary artery catheter at induction of general anesthesia (that includes patients with preoperative ejection fraction lower than 35 %, patients in preoperative renal insufficiency, patients with COPD). All patients with low cardiac output in the post-operative period also received a Swan-Ganz catheter.

LOW OUTPUT SYNDROME WAS DEFINED AS A CLINICAL PICTURE CHARACTERIZED BY A CARDIAC INDEX LOWER THAN 2 L / MIN / M², DESPITE OPTIMAL VASCULAR FILLING AND MAXIMAL INOTROPIC SUPPORT, FOR MORE THAN FIFTEEN MINUTES:

All patients with positive history of cigarette smoking, chest Roentgenogram, or findings evoking pulmonary disease at auscultation, were evaluated by means of preoperative Spirometric pulmonary function test and measurements of basal arterial blood gases. Chronic obstructive pulmonary disease (COPD) was defined as a condition characterized by an FEV1 lower than 70 %, forced vital capacity lower than 70 % and FEV1 / FVC lower than 60 %

Preoperative NYHA class was valued by two different cardiologists and in case of disagreement, a third cardiologist was asked for definitive diagnosis. Mitral incompetence was diagnosed with both ventriculography and transthoracic echocardiography. In case of doubt, final diagnosis was achieved with transesophageal echocardiography in the operating room.

MITRAL INCOMPETENCE OF MODERATE DEGREE WAS NOT CONSIDERED FOR SURGICAL CORRECTION:

The preoperative ejection fraction was quantified by ventriculography and by transthoracic echocardiography; the

post-operative ejection fraction was determined with transthoracic echocardiography, in some case with transesophageal echocardiography. Perioperative myocardial infarction was identified by the appearance of new electrocardiographic changes in the postoperative electrocardiogram or CK-MB elevation. All patients with ejection fraction lower than 35 %, underwent preoperative stress test with dobutamine.

Only coronary artery stenoses over 60 % were considered critical. No patient was supported with an intra aortic balloon pump (IABP) before surgery. Post-operative insertion of IABP was performed in case of cardiac index lower than 2 l / min / m², PCWP greater than 18 mmHg. In addition, mean arterial pressure less than 70 mmHg, despite maximal inotropic support or in case of serious ventricular arrhythmias.

STATISTICAL ANALYSIS

All data are presented as mean ± standard deviation. Single variable test was performed using Fisher's exact test or Mantel-Haenszel $^2$ for categorical variables and 2-sided unpaired t test for continuous variables. Functional class NYHA has been correlated with the preoperative creatinine values and the post-operative renal failure using univariate linear regression the number of distal and proximal anastomoses have been correlated to the post-operative renal failure using univariate linear regression; in both cases this type of analysis is more appropriated. Before being forced in the multivariate logistic regression, NYHA class, and number of distal and proximal anastomoses have been correlated to the post-operative renal failure using univariate linear regression; in both cases this type of analysis is more appropriated. Before being forced in the multivariate logistic regression, NYHA class, and number of distal and proximal anastomoses have been transformed in categorical variables as indicated in the table(s). All variables with p values < 0.1 were forced into a stepwise multiple logistic regression. All statistical tests were performed to reject the null hypothesis at a level of a = 0.05.

RESULTS

The mean age of our group of patients was of 77.37 ± 2.60 years (range between 75 and 86 years), 94 patients were male (61%) and 60 patients were female (39 %). 95 patients (61.7%) were in functional class NYHA I-II, 59 patients (38.3%) were in functional class NYHA III-IV.

The medium preoperative ejection fraction was 44.42 ± 12.82 %. The main preoperative characteristics of patients are shown in table 1.
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Figure 1
Table 1: Principal demographic and clinical characteristics.

<table>
<thead>
<tr>
<th>SEX</th>
<th>POSTOPERATIVE RENAL FAILURE</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Male</td>
<td>17 (8.3)</td>
<td>77 (39.9)</td>
</tr>
<tr>
<td>Female</td>
<td>5 (8.3)</td>
<td>55 (91.7)</td>
</tr>
<tr>
<td>Age (y)</td>
<td>77.02 ± 1.33 a</td>
<td>77.4 ± 1.64 a</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>80.0 ± 11.04 a</td>
<td>68.0 ± 11.18 a</td>
</tr>
<tr>
<td>NYHA CLASS</td>
<td>1 (6.2)</td>
<td>56 (76)</td>
</tr>
<tr>
<td>COPD</td>
<td>26 (8.2)</td>
<td>350 (45.2)</td>
</tr>
</tbody>
</table>

This table shows the results of the univariate analysis.

* Significative p values (< 0.05)
Numbers in parentheses are percentage

a mean standard deviation
NYHA = New York Heart Association
COPD = chronic obstructive pulmonary disease
LAD = left anterior descending coronary artery
RCA = right coronary artery

The number of distal anastomoses was 2.85 ± 0.95 per patient. The Left internal mammary artery (LIMA) was grafted onto the left anterior descending artery (LAD) in 144 patients (93.5%).

The main operative characteristics of patients are reported in table 2.

Figure 2
Table 2: Operative characteristics. This table shows the results of univariate analysis

<table>
<thead>
<tr>
<th>DISTAL ANASTOMOSIS</th>
<th>POSTOPERATIVE RENAL FAILURE</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-0</td>
<td>17 (6.2)</td>
<td>41 (17.1)</td>
</tr>
<tr>
<td>2-0</td>
<td>7 (7.7)</td>
<td>90 (39.8)</td>
</tr>
<tr>
<td>PROXIMAL ANASTOMOSIS</td>
<td>17 (18.8)</td>
<td>60 (50.2)</td>
</tr>
<tr>
<td>G1F</td>
<td>3 (2.4)</td>
<td>63 (29.6)</td>
</tr>
</tbody>
</table>

Numbers in parentheses are percentage

a p values < 0.05

LIMA = left internal mammary artery
CPB = cardiopulmonary by-pass
ACC = aortic cross clamp

Total hospital mortality has been 5.8 % (9 patients). 22 patients developed post-operative renal failure (14.3 %), 7 patients (31.81 %) needed CVVHD. Six patients (27.2 %) with post-operative renal insufficiency died. 5 patients out of the seven undergoing to dialysis died. (71.42%).

The univariate analysis of mortality showed a correlation between hospital mortality and post-operative renal failure (p < 0.0001, OR 9.41 C. I. 95 % 2.30 – 38.50). The variables taken in consideration in our study are listed in Appendix 1.

We have taken in consideration 46 different preoperative, intraoperative and post-operative variables.

Figure 3
Appendix 1: preoperative, operative and postoperative variables
From the result of the univariate analysis, it can be noticed as the incidence of the post-operative renal failure is meaningfully higher in patients with preoperative creatinine values over 1.7 mg. / dl. in patients in class NYHA III-IV and in patients with COPD. In attempt to verify a statistically meaningful correlation between preoperative NYHA class and high values of preoperative creatinine, we have carried out a linear regression confronting these two parameters; the result has not evidenced statistical significance (p= 0.149).

Male patients and those with left main stem disease have a greater incidence of post-operative renal failure, even if this difference does not reach statistical significance. The risk of postoperative renal failure does not seem to be correlated with progression of age from 75 years onwards. The univariate analysis of the operative risk factors (table. 2) shows that a higher number of proximal and distal anastomoses are a protective factor for the insurgence of post-operative renal failure. Patients who received less anastomoses have more risk of post-operative renal failure. Very important appears to be also the total amount of diuresis during the cardiopulmonary bypass time. Postoperative complications are shown in table. 3.

This table shows the results of univariate analysis. * p values < 0.005.

Numbers in parentheses are percentage
a mean standard deviation
b C.I. < 2 l/min/m², PCWP > 18 mmHg
IAPB = intraaortic balloon pump.

Univariate analysis of postoperative complications shows how postoperative low output syndrome, respiratory failure and total amount of post-operative bleeding are related to an increase of incidence of post-operative renal failure. (Table. 4) Logistic regression clearly evidences that independent risk factors of renal failure in this subset of patients are: elevated preoperative levels of serum creatinine, minor number of distal anastomoses and the post-operative low output syndrome.
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Figure 6
Table 4: Results of univariate analysis with unadjusted odds ratio.

<table>
<thead>
<tr>
<th></th>
<th>p</th>
<th>O.R.</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYHA class</td>
<td>0.01</td>
<td>2.70</td>
<td>1.07 - 6.79</td>
</tr>
<tr>
<td>Respiratory failure</td>
<td>0.001</td>
<td>5.83</td>
<td>1.78 - 18.90</td>
</tr>
<tr>
<td>Preoperative creatinine values over 1.7 g / dl</td>
<td>0.001</td>
<td>4.27</td>
<td>1.47 - 12.38</td>
</tr>
<tr>
<td>COPD</td>
<td>0.03</td>
<td>3.16</td>
<td>1.06 - 9.39</td>
</tr>
<tr>
<td>Number of proximal anastomoses</td>
<td>0.01</td>
<td>0.32</td>
<td>0.11 - 0.92</td>
</tr>
<tr>
<td>Number of distal anastomoses</td>
<td>0.001</td>
<td>0.218</td>
<td>0.0083 - 0.574</td>
</tr>
<tr>
<td>Low output syndrome</td>
<td>0.001</td>
<td>5.23</td>
<td>1.84 - 14.80</td>
</tr>
</tbody>
</table>

All reported data are only data with p value < 0.05.

COPD: chronic obstructive pulmonary disease.

Table. 5 shows the results of logistic regression analysis with the adjusted values of odds ratio. It can be noticed how high preoperative values of serum creatinine, increase the risk of post-operative renal failure of approximately 4 folds, the low output syndrome of approximately 5 times, while a greater number of distal anastomoses performed has a protecting effect.

Figure 7
Table 5: Multivariate logistic regression analysis

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>WALD</th>
<th>p</th>
<th>O.R.</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative creatinine &gt; 1.7 g/dl</td>
<td>1.093</td>
<td>6.01</td>
<td>0.0142</td>
<td>4.69</td>
<td>1.38 - 15.09</td>
</tr>
<tr>
<td>Number of distal anastomoses</td>
<td>-1.349</td>
<td>4.64</td>
<td>0.0312</td>
<td>0.26</td>
<td>0.07 - 0.88</td>
</tr>
<tr>
<td>Low output syndrome</td>
<td>1.6452</td>
<td>7.06</td>
<td>0.0078</td>
<td>5.18</td>
<td>1.54 - 17.42</td>
</tr>
</tbody>
</table>

In this case the odds ratio are adjusted and these are the independent risk factors for postoperative renal failure.

DISCUSSION

Our total hospital mortality has been 5.8 %, comparable to data reviewed in the literature from similar studies. (1, 2, 3, 4, 5, 6, 7, 8). Many studies have been carried out in order to define the risk factors for renal failure after cardiac surgery, but none has ever been made in order to estimate the same risk factors in a population of patients 75 years and older.

Post-operative renal failure following cardiac surgery is one of the most frequent and serious complications.

A large part of the literature agrees in defining advanced age as an important risk factor for insurgence of post-operative renal failure. The reported incidence of renal failure is very variable ranging from 0.7 % to 15 %, mostly because the definition of such complication is not uniform. Commonly renal insufficiency is considered as a condition in which post-operative serum creatinine level increases more than 50 % of basal value.

The use of this parameter in defining acute renal failure following cardiac surgery can be misleading, because most conditions of isolated increased post-operative creatinine values, are easily treated with medical therapy. For this reason most of the literature defines post-operative renal insufficiency as a condition in which, beside an increase of creatinine values, oliguria also is a prominent feature, associated with metabolic and electrolyte alterations leading quite possibly to the use of dialysis. This has been the definition of renal failure that we have adopted.

The incidence of renal failure in our series has been 14.3 %, associated with a mortality rate of 22.7 %, comparable with reports in most part of the literature (9, 10, 11). Overall, 31.81 % of patients in renal insufficiency needed dialysis and out of these 85%, died. Mortality rate for patients undergoing dialysis has been high as confirmed by many papers in the international literature although recent reports show a significant improvement in results probably related to early institution of dialytic therapy (12). Many authors have described the prognostic factors for risk of post-operative renal failure insurgence (9, 10, 11).

The preoperative risk factors we have identified are in line with those identified from the international literature; preoperative serum creatinine levels higher than 1.7 mg / dl are universally recognized as one of the most important preoperative risk factors. In our series, the NYHA functional class and chronic obstructive pulmonary disease (COPD) appear to be independent preoperative risk factors in this subset of patients. Chertow and co workers (11) have stratified the preoperative risk factors for renal failure in an immense population of patients and they identified the same risk factors we have singled out; this study is one of the rare works that identifies COPD as a significant risk factor for post-operative renal insufficiency.
It is possible that the identification of this risk factor both in our study and in Chertow's one, could be because we have examined a population of old patients only, while Chertow and colleagues worked over a very high number of patients. Our interpretation of this evidence is that, as age increases, COPD assumes more and more importance in determining the onset of renal insufficiency. Therefore, this important data must be considered when posing indication for coronary revascularization in elderly patients. In a univariate analysis the risk of post-operative renal Insufficiency in patients with elevated preoperative serum levels of creatinine increases four folds, in patients with COPD increases three folds, in patients in NYHA class III-IV, increases 2 folds.

From our study emerges interesting evidence: the univariate analysis of operative risk factors shows an inverse correlation between number of anastomoses and incidence of post-operative renal failure. Our interpretation of this evidence is that incomplete revascularization exposes to a greater incidence of post-operative low output syndrome. In fact, the number of anastomoses and the incidence of low output syndrome are statistically meaningfully correlated (p= 0.015). These data are confirmed from the result of the multivariate analysis too. We can therefore emphasize that complete revascularization diminishes the incidence the post-operative renal failure.

From an overview of the recent international literature very interesting data are emerging: many cardiac centres currently prefer to perform coronary surgery avoiding cardiopulmonary bypass in patients at high surgical risk such as the one above mentioned. Ascione and coll. (16) demonstrated that renal damage in patients undergoing CABG without CPB is lower, the indices of renal damage (N-acetil-beta-glucosaminidase) being lower in the off-pump group of patients.

Yokoama and coll. (17) demonstrated that, in old patients operated on without CPB, the incidence of renal failure is reduced (3.6 % vs. 15.5 %). In our series of patients operated on with CPB we had 35 % of patients with high preoperative values of creatinine, 30 % of patients with COPD and 22 % of patients in class NYHA III-IV developing post-operative renal failure.

Arom (18) also demonstrated a reduced incidence of post-operative renal failure in a group of high-risk patients operated on without CPB. Guler and coll. (19), demonstrated that morbidity in patients with COPD undergoing off-pump CABG is lower compared to those operated on with CPB.

CONCLUSIONS
In our view based on international data associated with the results of our experience with this subset of patients lead us to conclude that coronary surgery in patients over 75 years of age with preoperative renal insufficiency or with COPD has better outcome if performed without CPB.

In our experience insertion of a pulmonary catheter appears recommendable in all patients over 75 years with high preoperative class NYHA, preoperative elevated serum creatinine levels and COPD as early diagnosis and appropriate therapy for post-operative low output syndromes is paramount, in order to prevent the insurgence of post-operative renal failure. Once again it must be emphasized that coronary revascularization performed without CPB cannot be compromised with an incomplete revascularization.

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References
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