The impact of major perioperative renal insult on long-term renal function and survival after cardiac surgery†

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Abstract

Temporary renal replacement therapy (RRT) facilitates recovery from a major perioperative renal injury and, although RRT can improve the hospital outcome, it is not known as to whether it mitigates long-term renal sequelae. Therefore, we investigated the risk of long-term dialysis after RRT post-cardiac surgery. We analysed prospectively the data collected for all hospital survivors who received RRT following cardiac surgery between March 1996 and July 2010, excluding those on dialysis preoperatively or with a functioning renal transplant. The follow-up data were obtained for all surviving patients. The mean age of the 82 patients was 68.6 ± 9.9 years, and 60 (73%) were male. Severe pre-existing renal dysfunction with a serum creatinine level of >200 μmol/l was present in 15 (18%) patients and diabetes in 31 (38%) patients. Operative procedures included redo surgery (n = 11, 13%) and thoracic aortic surgery (n = 9, 11%). During a 13.4-year follow-up, there were 38 late deaths. Only three patients with severe preoperative renal dysfunction received dialysis. The Kaplan–Meier 5- and 7-year survival rates for this patient cohort were 54% and 38%, respectively. In conclusion, a major renal insult requiring temporary RRT after cardiac surgery does not increase the risk for renal dialysis in the long term for patients with normal renal function preoperatively.

Keywords: Cardiac surgery • Kidney (acute injury) • Renal replacement therapy • Outcomes

INTRODUCTION

Postoperative acute renal failure is a major complication of cardiac surgery with a reported incidence of 5–30% [1–3]. Renal dysfunction after cardiac surgery may be temporary and resolve with conservative management, but severe renal impairment usually warrants renal replacement therapy (RRT) in ~5% of cases and is associated with an increased operative mortality of up to 90% [4, 5]. Whereas, the long-term survival in patients requiring RRT in the postoperative period after cardiac surgery has been reported [1–4], data about the impact on the long-term renal function is lacking.

The present study sought to determine the long-term prognosis for patients who survived to hospital discharge after sustaining a major renal insult as defined by the need for RRT in the postoperative period. In order to answer the question often asked by patients with regards to the need for dialysis in the future, we specifically set out to determine the need for dialysis in the long term as the primary study objective.

PATIENTS AND METHODS

Patient cohort

The clinical data for all patients undergoing cardiac surgery at our cardiac centre are prospectively collected and stored in a computerized database and maintained and locally validated by dedicated staff. After obtaining approval from the Medical and Ethics Committee of our institution and a waiver for patient consent, we identified patients who had received RRT in the postoperative period and survived to hospital discharge between March 1996 and July 2010 from the database. Patients who were on dialysis before surgery and those with functioning renal transplants were excluded. We retrieved the demographical parameters, preoperative variables, intraoperative details and postoperative outcomes for all the patients.

Follow-up

The late follow-up data were obtained using The National Health Service (NHS), tracing service to identify survivors in November 2010. Survivors were then sent letters and contacted by telephone to enquire about their renal status post-cardiac surgery. Additionally, the respective general practitioners for all the patients (including the deceased patients) were contacted by telephone for similar information. The regional renal database was also interrogated to identify patients who had required subsequent management by renal physicians, with or without renal dialysis. The last recorded serum creatinine values were obtained from the regional pathology databases and/or the records of the general practitioners. The patient selection method is shown in Fig. 1. The follow-up was 100% complete.
using the Kaplan–Meier method. The analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 17.0 for windows (SPSS Inc., 2005, Chicago, IL, USA), and the statistical significance was set at $P < 0.05$.

**RESULTS**

The mean age of the study population ($n = 82$) was $68.6 \pm 9.9$ years (range 33–91), and 60 (73%) were male. The baseline characteristics of the study group are listed in Table 1. Severe renal dysfunction with a serum creatinine level of >200 µmol/l was present in 15 patients (18%) preoperatively. Eleven patients had prior cardiac surgery and, in half of the study group, surgery has been performed non-electively; 16% ($n = 13$) and 6% ($n = 5$) had undergone emergency and salvage operations, respectively. The vast majority of procedures were done using cardiopulmonary bypass. The mean additive European System for Cardiac Operative Risk Evaluation (EuroSCORE) was $7.3 \pm 3.6$. During a mean follow-up of 5.2 years (range 1–13.4 years), there were 38 late deaths.

**Renal prognosis and long-term survival**

Of the 82 patients, only three patients required renal dialysis in the follow-up period and all these three patients had severe renal dysfunction with a serum creatinine level of >200 µmol/l, preoperatively. None of the patients with the preoperative serum creatinine level of <200 µmol/l had renal dialysis (Fig. 2). Eight of the 15 patients (53%) with a serum creatinine level of >200 µmol/l compared with 10 of the 67 (15%) with the serum creatinine level of <200 µmol/l were under surveillance by renal physicians for deterioration of their renal function (Fig. 3). Interestingly, during follow-up, the serum creatinine levels peaked to >200 µmol/l in 24 of 67 patients (36%) who had lower levels preoperatively.

All-cause mortality occurred in 38 patients during the follow-up period, and the majority of these deaths (58%, $n = 22$) were observed within a year of hospital discharge. The Kaplan–Meier 5- and 7-year survival rates were 54% and 38%, respectively (Fig. 4). The risk factors for late death, by multivariate analysis, were: the use of intra-aortic balloon pump (hazard ratio [HR] 3.6, 95% confidence interval [CI] 1.4–9.2), severe preoperative renal dysfunction (HR 3.2, 95% CI 1.3–7.7), male (HR 2.76, 95% CI 1.2–6.5), diabetes mellitus (HR 2.4, 95% CI 1.1–5.1), age, in years, at surgery (HR 1.05, 95% CI 1.01–1.1), cumulative cross-clamp time in minutes (HR 1.02, 95% CI 1.0–1.04), cumulative minutes on bypass (HR 0.99, 95% CI 0.98–1.00) and the use of cardiopulmonary bypass (HR 0.26, 95% CI 0.07–0.98).

**DISCUSSION**

A major renal injury complicating cardiac surgery is associated with a high operative and late mortality. Our study, like several others [5, 6], found an in-hospital mortality of 65%. Chertow et al. [6] have reported that renal failure requiring dialysis is an independent determinant of death with an odds ratio of 7.9, using a multivariate analysis. However, it has been suggested that earlier institution of dialysis and normal preoperative renal function diminishes this mortality risk [7].

The long-term mortality impact of a major postoperative renal injury has been well reported. Hobson et al. [8] have studied the
late mortality risk of acute kidney injury after cardiothoracic surgery in 3240 patients, using the risk injury failure loss end stage kidney disease (RIFLE) classification [5]. They have also found that any form of postoperative acute renal injury decreased survival, with survival rates of 89 and 44% at 1 and 10 years compared with 95 and 63% for patients without a postoperative acute renal injury. The 10-year survival for the RIFLEmax-F was only 26%. Leacche et al. [9] also reported in their series of 13,847 patients who underwent procedures with cardiopulmonary bypass, a 10% 1-year survival for those suffering from acute renal failure requiring dialysis. More recently, it has been reported that even small changes in the serum creatinine level increases long-term mortality with the risk persisting even if the serum creatinine level returns to the baseline prior to the hospital discharge [10]. The findings of our study corroborate these previous reports of the poor long-term survival in patients whose postoperative recovery is complicated by the major renal injury that warrants RRT. Additionally, we have found that preoperative renal dysfunction had a discrepant influence on the long-term survival in this cohort of patients. The late survival was better in the subgroup with the preoperative serum creatinine level of <200 µmol/l with a 5-year survival of 62% compared with the subgroup with the preoperative serum creatinine level of >200 µmol/l who had a 5-year survival of 27%. The continued risk of death in the long term has been explained by the finding that renal blood flow and clearance function can remain impaired for a prolonged period of time, even though the serum creatinine level may be normalized at hospital discharge [11]. Ongoing progressive damage after the major renal injury may result in a decrease in the capillary density of peritubular capillaries (referred to as ‘rarefaction’) [12]. As a result, the determination of the impact of the major postoperative renal injury on late renal prognosis is pertinent.

The principal finding of this study relates to the long-term renal prognosis in patients who suffer renal injury significant enough to require temporary RRT. Our study shows that the risk of long-term permanent dialysis in this group of patients is minimal (4%) and this risk exists for those with preoperative renal dysfunction. None of the patients with normal renal function before surgery required permanent dialysis, although some showed a slight deterioration in renal function in the long term, which could be argued as an age-related change. Patients with preoperative renal dysfunction were also more likely to have a further decline of renal function than those with normal renal function before surgery. In their study of 92 patients, Luckraz et al. [13] found two patients (2%) who underwent postoperative RRT to be on permanent dialysis. In contrast, smaller studies report higher rates of late permanent dialysis between 24% and 64% [7, 8].

The limitations of this study include the retrospective design with its inherent bias and sample size. However, this study provides the long follow-up and data about late renal function and renal dialysis in patients with a post-cardiac acute renal injury which has not been well reported. The use of a serum creatinine level of 200 µmol/l as a reference level for the definition of severe renal dysfunction, though based on the original EuroSCORE definition, can also attract criticism. However, this was used only to show the possible differing renal and survival outcomes based on the preoperative renal function, the principal message of this paper has not been compromised. Clearly, the better marker of impaired renal function, the estimated glomerular filtration rate, is now widely used and will guide future studies. Even though a variety of cardiac procedures such as coronary
artery bypass grafting, valvular heart surgery, ascending and thoracic aortic operations and others, were performed in the study cohort, we are still able to make a determination of the impact of postoperative RRT on the long-term renal prognosis in survivors.

In conclusion, our data suggest that there is a minimal risk of long-term renal dialysis for patients with normal preoperative renal function who suffer a major postoperative renal insult requiring renal replacement after cardiac surgery. For those with a preoperative renal dysfunction, the risk of long-term permanent renal dialysis is low but continued surveillance for the deterioration of renal function may be necessary.

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Conflict of interest: none declared.

REFERENCES


