

# Prevalence and Risk Factors of Acute Renal Failure after Cardiac Surgery in Southern Iran

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## Abstract

**Background:** Acute renal failure requiring renal replacement therapy after cardiac surgery is still a cause of major morbidity and mortality worldwide. A number of risk factors for the development of acute renal injury after cardiac surgery have been previously described and based on these variables; several scoring algorithms were proposed. Predictive value of these algorithms in Iran is not described. This study investigates these risk factors among our patients in southern Iran.

**Methods:** Two hundred and forty patients with normal kidney function who were candidates for cardiac surgery were enrolled and their baseline data were collected. Diabetes mellitus and age were selected as more controversial preoperative risk factors. Clamp and pump time were also selected as intra-operative risk factors and the type of operation was also considered as an independent risk factor. The patients were categorized in two groups including group 1: Patients with post-operation normal kidney function and group 2: Patients with post-operation ARF. All patients were followed with serial measurement of serum creatinine post-operation.

**Results:** The incidence of acute renal failure was 11.25%. Mean age of the patients in group 1 was  $54.24 \pm 15.88$  and in group 2 was  $52.85 \pm 18.20$  years. There was not any significant correlation between duration of clamp time and post operation acute renal failure. Clamp time in group 1 was  $51.49 \pm 11.88$  and in group 2 was  $53.48 \pm 13.40$  min. Duration of pump time in group 1 was  $63.31 \pm 12.56$  min and in group 2 was  $78.07 \pm 10.85$  min. The difference was statistically significant. Forty two (20%) of the patients in group 1 and 13 (50%) in group 2 were diabetic.

**Conclusion:** Although several scoring algorithms are available for prediction of post-cardiac surgery complications, these can also be matched with our patients' criteria enhancing their accuracy for our situation.

**Keywords:** Acute renal failure; Cardiac surgery; Risk factors

## Introduction

Acute renal failure (ARF) is considered as a serious complication of cardiac surgeries occurring in 1-30 % of patients and is associated with high morbidity and mortality. It is noted that 1-5% of these patients require renal replacement therapy.<sup>1-3</sup> On the other hand,

it has been reported that a transient kidney dysfunction (i.e. decline in glomerular filtration rate) is a regular consequence of extracorporeal circulation.<sup>4</sup> ARF can arise from a variety of causes including intra-operation hypotension, postoperative cardiac complications that impair renal perfusion, atheroemboli and exposure to contrast media. A similar relationship between post-operation ARF and a modest rise in preoperative serum creatinine has been demonstrated in other studies.<sup>3-5</sup>

Other important independent risk factors for developing ARF are New York Heart Association

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functional class 4, emergency surgery, peripheral arterial disease, valve surgery and the need for preoperative intra-aortic balloon pump.<sup>1-6</sup> Advanced age, left ventricular ejection fraction less than 50% and diabetes mellitus were shown as risk factors generally associated with increased risk of renal failure.

As patients undergoing cardiac surgery at Cardiac Surgery Ward of Faghihi Hospital affiliated to Shiraz University of Medical Sciences in Shiraz, southern Iran had commonly more than one of the above baseline risk factors, this study was performed to identify whether diabetes mellitus, type of operation, clamp and pump time and age are associated with increase in the risk of post-operation renal failure among our patients.

## Materials and Methods

According to the definition of the Society of Thoracic Surgery (STS), ARF was defined as an increase of serum creatinine  $>2$  mg/dl with a minimum doubling of the preoperative value, or a new requirement for renal replacement therapy. Clamp time was defined as a period of time between clamping of ascending aorta till releasing the clamp of the aorta and pump time was considered as duration of cardiopulmonary bypass.

Two hundred and forty patients (192 male, 48 female) referred to Cardiac Surgery Ward of Faghihi Hospital affiliated to Shiraz University of Medical Sciences in Shiraz, southern Iran between April 2005 and April 2006 were enrolled. End stage renal disease patients under routine hemodialysis and renal transplant recipients were excluded.

The variables measured at the baseline included history of diabetes mellitus, age, sex, weight (Kg) and serum creatinine. Serial measurements of serum creatinine were undertaken for all patients in an interval of 24 hours in the post-operative period during ICU admission. Clamp time and pump time (minutes) were also considered as intra-operative risk factors, and the type of operation was considered as an independent risk factor too. All operations were categorized in five groups including coronary artery bypass graft, valvular replacement, correction of tetralogy of fallot, closure of VSD, ASD and others (Table 1).

Statistical analysis was performed using SPSS program (version 15, Chicago, IL, USA). Wilcoxon's rank-sum and Mann-Whitney tests were used to compare continuous variables between patients with post-operative ARF. Pearson Chi-Square and student T tests were used to determine the relationship between

the type of operation and post-operation renal failure. All continuous variables were expressed as mean $\pm$ standard deviation. The results were considered statistically significant when  $p$  value was  $< 0.05$ .

**Table 1:** Type of operations.

Type of operation	No. (%)
Coronary artery bypass graft	183 (76.25)
Valve replacement	16 (6.67)
Correction of TOF	7 (2.91)
Closure of ASD/VSD	16 (6.67)
Others	18 (7.50)

(TOF: Tetralogy of fallot, ASD: Atrial septal defect VSD: Ventricular septal defect)

## Results

The mean age of patients was  $54.08 \pm 16.12$  years. The baseline plasma creatinine was  $1.25 \pm 0.28$  mg/dl. Demographic characteristics of the study group were shown in Table 2. The incidence of renal failure among our patients was 11.25%. Twenty seven patients (11.25%) developed acute renal failure according to the definition (Male: 20, female: 7). The patients were categorized in two groups including group 1: Patients with post-operation normal kidney function and group 2: Patients with post-operation ARF. Mean age of patients in group 1 was  $54.24 \pm 15.88$  and in group 2 was  $52.85 \pm 18.20$  years ( $p=0.805$ ).

**Table 2:** Demographic characteristics of the patients.

Patients' characteristics	No. (%) or Mean $\pm$ SD
Mean age (years)	$54.08 \pm 16.12$
Male	192 (80%)
Female	48 (20%)
Weight (kg)	$63.82 \pm 21.11$
Baseline creatinine (mg/dl)	$1.25 \pm 0.28$
Diabetic patients	55 (22.9%)

(Kilograms: kg, milligram: mg, deciliter: dl).

There was not any significant correlation between duration of clamp time and post-operation ARF. Clamp time in group 1 was  $51.49 \pm 11.88$  and in group 2 was  $53.48 \pm 13.40$  min ( $p=0.506$ ). Duration of pump time in group 1 was  $63.31 \pm 12.56$  and in group 2 was  $78.07 \pm 10.85$  min. The difference was statistically significant ( $p=0.044$ ). Forty two (20%) of the patients in group 1 and 13 (50%) patients in group 2 were diabetic ( $p=0.021$ ) (Table 3).

**Table 3:** Relationships between variables of group 1 and group 2.

Variables	Post-operation normal kidney function (Group 1)	Post-operation ARF (Group 2)	P value
Number	213	27	
Male	172	20	
Female	41	7	
Age (years)	54.24±15.88	52.85±18.20	0.805
Diabetes mellitus	42	13	0.021
Pump time (min)	63.31±12.56	78.07±10.85	0.044
Clamp time (min)	51.49±11.88	53.48±13.40	0.506

## Discussion

Post-cardiac surgery ARF is still a leading cause of morbidity, mortality, prolonged hospitalization and increase in the health care cost.<sup>7</sup> Thakar *et al.*,<sup>6</sup> developed a clinical score to predict ARF after cardiac surgery. In a cohort study of 24,773 patients,<sup>1</sup> Chertow *et al.* developed a risk stratification algorithm to estimate the risk and design interventions to improve the outcome. A large study designed a bedside tool for predicting the risk of postoperative ARF too.<sup>8</sup> According to these studies, numerous variables were identified as risk factors for the development of ARF including age, male sex, diabetes mellitus, duration of bypass and aortic cross-clamping.<sup>9,10</sup> In another study, the elderly and female patients had a higher risk of ARF.<sup>11</sup>

Among our patients, no relationship between the age and development of post-operation renal failure was noticed ( $p=0.805$ ).

Effect of diabetes mellitus on post-operation ARF has been controversial. In some studies, diabetes mellitus is associated with the increase in risk of post-operation ARF, while others have failed to show this association.<sup>12</sup> In our study, diabetic patients had a higher incidence of post-operation ARF.

In this study, duration of pump time was significantly related to post-operation ARF, but there was

not any significant correlation between duration of clamp time and post-operation ARF.

Several studies<sup>1,6,8</sup> reported the risk factors of post-operation ARF and predictive score charts were designed for prediction of post-operation complications such as Euro SCORE, Parsonnet score and Cleveland clinic score. These scoring systems might be beneficial for prediction of post-operation complications but their usefulness among our patients was unclear. There are controversies on risk factors that may promote post-operation ARF like diabetes mellitus,<sup>12</sup> and gender of patients.<sup>9-11</sup>

Although several scoring algorithms are available for prediction of post-cardiac surgery complications, these can also be matched with our patients' criteria enhancing their accuracy for our situation. Considering controversies, more studies still seem necessary to determine the risk factors of ARF after cardiac surgery.

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