

Original Article

EFFECT OF AORTIC CROSS CLAMP TIME ON RENAL FUNCTION IN PATIENTS UNDERGOING CORONARY ARTERY BYPASS GRAFTING

Usman Javed Iqbal, Majid Kaleem, Tahira Kanwal and Hamid Hassan

Objective: The aim of the study is to see the effect of aortic cross clamp time on renal function post operatively.

Material and Methods: In a prospective study 90 patients were selected for CABG first time with normal renal function. A questionnaire was made to see the effect of aortic cross clamp time on post operative renal function. Demographic factors, pre operative, intra operative and post operative variables were evaluated. The patient were divided into two groups according to aortic cross clamp time, patient with aortic cross clamp time 50 minutes and patients with aortic cross clamp time > 50 minutes ultimately they were evaluated to see the occurrence of acute kidney injury (AKI).

Results: AKI was observed in 6 patients with aortic cross clamp time \leq 50 minutes and 36 patients with aortic cross clamp time > 50 minutes. The aortic cross clamp time was highly associated with blood urea post operatively at day 1 (p value 0.002), day 2 (p-value 0.000) and day 3 (p-value 0.000). It had significant effects on serum creatinine postoperatively day 1 (p-value 0.000), day 2 (p-value 0.005) and day 3 (p-value 0.001). It also had significant effect on reduction of GFR post operatively day 1 (p-value 0.011), day 2 (p-value 0.003) and day 3 (p-value 0.001).

Conclusion: The greatest likelihood of developing acute kidney injury (AKI) after CABG was observed with prolonged aortic cross clamp time. The levels of blood urea and serum creatinine was increased in patients with aortic cross clamp time > 50 minutes. Glomerular filtration rate (GFR) was reduced with aortic cross clamp time > 50 minutes.

Key words: Cardiopulmonary bypass, Acute kidney injury, Aortic cross clamp, Ischemic period, Morbidity.

Introduction

Coronary artery disease (CAD) is narrowing of coronary arteries which supply oxygen and nutrients to the heart. Three fourths of global deaths due to CAD occurred in the low and middle income countries.¹

There are three methods of intervention of CAD: Medical treatment, percutaneous coronary intervention (PCI) and CABG.² Randomized trials proved that CABG is superior to both of these therapeutical regimen.³ The aorta at abdominal or thoracic level is clamped to provide dry operative field with good visibility during surgical intervention however it is complicated by ischemia of lower extremities and vital organs such as kidneys. These high complication rates result in part from pathophysiologic disturbances that occur during cross clamping and unclamping of the aorta. The duration of aortic cross clamp not only affects some vital organs but also the overall results of surgical intervention.⁴

Acute kidney injury (AKI) after cardiac surgery is a major health issue. Lacking effective therapies, risk

factor modification may offer a means of preventing this complication.⁵ Acute renal failure (ARF) is a recognized complication following cardiac surgery. ARF was defined as doubling of serum creatinine concentration to >0.13 mmol/L if serum creatinine was <0.13 mmol/L pre-operatively, or else a rise in serum creatinine of $2:0.10$ mmol/L after cardiac surgery.⁶ Some data indicate that 10 to 20% of patients who undergoing a CABG procedure have a serum creatinine of more than 1.5 mg/dl.⁷ Renal dysfunction is an important predictor of outcome in terms of in hospital mortality, morbidity, and midterm survival in patients undergoing CABG.⁸ Acute renal failure (ARF) occurs in up to 30% of patients who undergo cardiac surgery, with dialysis being required in approximately 1% of all patients. The development of ARF is associated with substantial morbidity and mortality independent of all other factors. The pathogenesis of ARF involves multiple pathways. Hemodynamic, inflammatory, and nephrotoxic factors are involved and overlap each other in leading to kidney injury. And one of them is prolonged aortic cross clamp time.⁹ The purpose of

this study is to facilitate the understanding the pathophysiologic derangement in kidneys during clamping and unclamping of aorta and to provide a basis for rational therapy to reduce the complication and improve the outcome.

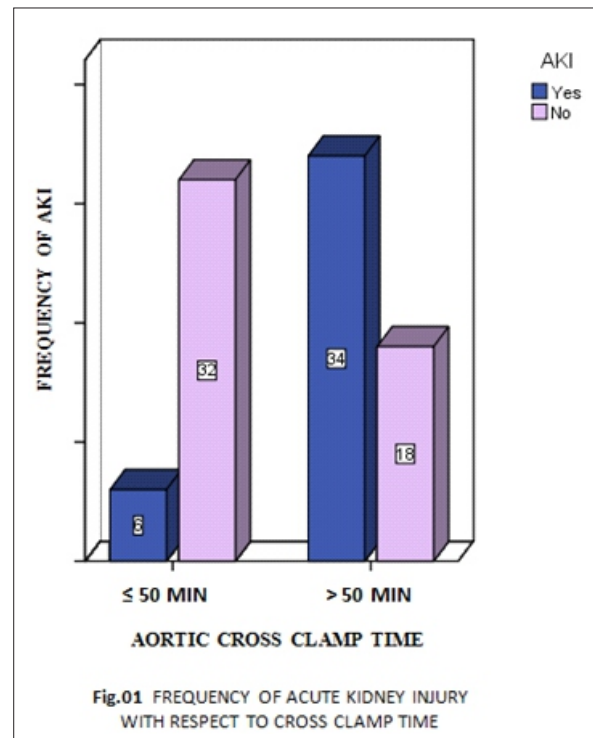
Materials and Methods

It was a prospective longitudinal study of 90 patients undergoing CABG in Punjab institute of cardiology with three days follow up after surgery. Study was completed in six months. We used non probability (purposive) sampling. All patients from age 30 years onwards regardless of gender who underwent CABG were included in the study. Reoperation and all those patients that were having previous renal function impairment were excluded from the study. Patients were followed up for three days after surgery. In addition to collecting basic demographic details, frequency of postoperative Creatinine, urea levels, GFR and other related perfusion parameters were noted down on a short structured questionnaire. Patients were asked about the presence of chronic hypertension and diabetes mellitus. Information was also obtained regarding smoking history and history of heart disease in first degree relatives. Patients were divided into two groups i.e; those with aortic cross clamp time ≤ 50 min and those with aortic cross clamp time > 50 min. Both descriptive and inferential statistical analyses were done in Statistical Package for Social Sciences (SPSS) version 16.0. We had access to the original raw data and these data were combined to perform the analyses. Categorical data were presented as percentages and in form of graphs while descriptive and frequency distribution was used for quantitative analyses. Independent sample t-test was used to compare the means of two groups in pre & post-op conditions for two groups. p-value ≤ 0.05 was considered as significant.

Results

The mean age of our patients who underwent CABG, was 54.36 ± 9.8 and there was female predominance (40% males and 60% females). Out of 90 patients, 36(40%) were diabetics, 56(62.2%) were hypertensive, 34(37.8%) were smokers and 20(22.2%) were presented with a strong family history of heart disease. Mean CPB time was recorded as 97.5 ± 45.1 . All patients were perfused with the mean pressures of 60.5 ± 10.2 . Out of 90 patients 38 were having aortic cross clamp time ≤ 50 minutes and 52 were having aortic cross clamp time > 50 minutes. Of 38 patients with cross clamp time

≤ 50 minutes; acute kidney injury (AKI) was observed in only 6 patients while patients with aortic cross clamp time > 50 minutes acute kidney injury (AKI) was observed in a significant number of patients i.e. 34 out of 52; as shown in Fig-1.



with respect to urea levels there was a significant effect of aortic cross clamp time in successive postoperative day 1, 2 and 3. Patients with aortic cross clamp time ≤ 50 minutes has mean blood urea levels 38.10 ± 19.27 , 47 ± 22.58 and 47.05 ± 24.60 for day 1, 2 and 3 respectively. For patients with aortic cross clamp time > 50 minutes mean blood urea levels were 53.16 ± 25.91 , 78.5 ± 50.64 and 77.34 ± 35.183 for postoperative day 1, 2 and 3 respectively. p-values 0.002, 0.000 and 0.000 for these respective days are significant.

Similarly for serum creatinine levels there was a significant effect of aortic cross clamp time in successive first three postoperative days. Patients with aortic cross clamp time ≤ 50 minutes had mean serum creatinine levels 1.18 ± 0.44 , 1.33 ± 0.87 and 1.29 ± 0.78 for postoperative day 1, 2 and 3 respectively. For patients with aortic cross clamp time > 50 minutes mean serum creatinine levels were 1.58 ± 0.55 , 1.80 ± 0.56 and 1.81 ± 0.49 for postoperative day 1, 2 and 3 respectively. p-values 0.002, 0.000 and 0.000 for these respective days signify an association between

aortic cross clamp time and serum creatinine levels. With respect to glomerular filtration rate (GFR) there was also a significant effect of aortic cross clamp time in first three successive postoperative days. Patients with aortic cross clamp time ≤ 50 minutes had mean GFR 76.24 ± 35.25 , 76.74 ± 43.53 and

73.69 ± 34.39 for postoperative day 1, 2 and 3 respectively. For patients with aortic cross clamp time > 50 minutes mean GFR was 59.13 ± 21.76 , 52.24 ± 23.17 and 50.86 ± 23.11 for postoperative day 1, 2 and 3 respectively. p-values 0.002, 0.000 and 0.000 for these respective days were significant.

Table-1: Shows the comparison between the urea, creatinine and GFR levels between the two groups i.e. patients with aortic cross clamp time ≤ 50 min & patients with aortic cross clamp time > 50 min, for successive three postoperative days.

		X-clamp time < 50 min Mean \pm S.D	X-clamp time > 50 min Mean \pm S.D	p-value
Day-1	Urea	38.1 \pm 19.2	53.1 \pm 25.9	0.002
	Creatinine	1.18 \pm 0.44	1.5 \pm 0.55	0.000
	GFR	76.2 \pm 35.2	59.1 \pm 21.7	0.011
Day-2	Urea	47 \pm 22.5	78.5 \pm 50.6	0.000
	Creatinine	1.33 \pm 0.87	1.80 \pm 0.56	0.005
	GFR	76.7 \pm 43.5	52.2 \pm 23.1	0.003
Day-3	Urea	47 \pm 24.6	77.3 \pm 35.1	0.000
	Creatinine	1.29 \pm 0.78	1.81 \pm 0.49	0.001
	GFR	73.6 \pm 34.3	50.8 \pm 23.1	0.001

P-value < 0.05 significant

Discussion

Acute kidney injury (AKI) is a major complication after cardiac surgery.¹⁰ According to another research risk factors associated with postoperative ARF were advanced age, diabetes mellitus, hypertension, high preoperative serum creatinine levels, impaired left ventricular function, urgent operation or reoperation, concomitant procedures, low cardiac output state, re-exploration for bleeding or pericardial tamponade and prolonged cardiopulmonary bypass (CPB) and aortic cross clamp periods.¹¹ The causes of renal dysfunction are multifactorial with cardiopulmonary bypass⁶ producing harmful effect for renal function.¹² The non physiological state of cardiopulmonary bypass (CPB) triggers inflammatory cascade and coagulation disorders that change renal function. Patients with renal dysfunction preoperatively affect long term survival.⁸ Recently it has been discussed that not using the CPB during surgery may protect renal function.¹³ Some authors conclude that preoperative renal insufficiency and postoperative hypotension, CPB time greater than 140 minutes, prolonged aortic cross clamp time and old age, history of diabetes mellitus, and preoperative congestive heart failure are independent risk factors

for development of renal dysfunction.¹⁴

In this prospective study, 90 patients were selected for CABG. Patients were divided into two groups according to the aortic cross clamp time, patients with aortic cross clamp time less than or equal to 50 minutes, and patients with aortic cross clamp time more than 50 minutes and they were evaluated for occurrence of acute kidney injury after cardiac surgery. According to Walhberg *et al* there is 10 fold risk of post operative renal dysfunction when suprarenal aortic clamping was greater than 50 minutes as compared with 30 minutes or less. If suprarenal clamp duration (renal ischemia time) is brief, patients with normal preoperative creatinine levels exhibit no increase or a marginal increase in BUN or creatinine levels after surgery. Accordingly, suprarenal aortic clamping less than 50 minutes in this patient group appears safe and well tolerated.¹⁵ In patients with a preoperative creatinine > 4.0 mg/dl, the risk for acute renal failure rises to 25 to 28%.¹⁶ The development of acute renal failure is associated with 40-50% reduction in renal blood flow. Following cross clamp of aorta there is high risk of tubular necrosis. Svensson and colleagues reported an overall hospital incidence of dialysis following ARF of 5.5% and hospital mortality of 63%.¹⁷

According to Zakeri *et al* a raised serum creatinine or a Reduced estimated GFR were both independent and strong predictors for adverse outcomes. It is known that there is a group of patients in whom, despite a near normal creatinine, the GFR is reduced and thus, GFR may be a more accurate parameter than serum creatinine to predict long term outcome.⁽⁸⁾ According to our study there is increase in serum creatinine and reduced GFR in patients with prolonged aortic cross clamp time. The patients with aortic cross clamp ≤ 50 min did not showed significant rise in serum creatinine, blood urea levels and no effect on GFR. While patients with aortic cross clamp time more than 50 min showed significant rise in serum creatinine, urea and reduced GFR postoperatively at day 1, 2 and day 3. So the results of our study are same as that of previous

literatures.^{8,11,15} There were several limitations in this study, it is an observational study done for short duration in a single center. During this study no patients were on dialysis, because patient were assessed for 3 days after operation and dialysis may started after fifth post operative day.

Conclusion

The study concludes that aortic cross clamp time has significant effect on post operative renal dysfunction. Aortic cross clamping time less than 50 minutes in the patients appears safe for renal protection. As aortic cross clamping time increases the safety margin decreases and there is more risk of developing renal dysfunction post operatively.

Department of Cardiology, Gulab Devi PGMI Lahore.

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