

Off-pump versus on-pump coronary artery bypass grafting in patient of impaired renal function

Md. Alauddin, Aslam Hossain, Rezwanul Hoque and Asit Baran Adhikary

Article Info

Department of Cardiac Surgery, Faculty of Surgery, Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka, Bangladesh

For Correspondence:

Md. Alauddin
mdalauddin1822@gmail.com

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Abstract

The purpose of this study was to compare the renal function in patients undergoing coronary artery bypass grafting in off-pump and on-pump having pre-operative impaired renal function. In the on-pump, the serum creatinine and urea levels were significantly increased on post-operative day 1, 3 and 7. On day 1, it was maximum, then gradually decreased but not reached to pre-operative level. In case of off-pump, serum creatinine and urea levels were significantly increased on post-operative day 1 and 3. On day 1, it was maximum. Then decreased and the serum creatinine reached below pre-operative level on day 7. In case of on-pump, the creatinine clearance rate was significantly decreased on post-operative day 1, 3 and 7. On day 1, it was minimum. Then gradually increased but not reached the pre-operative level. In case off-pump, the creatinine clearance rate was significantly decreased on day 1 and 3. On day 1, it was minimum, then gradually increased and reached above the pre-operative level. A significant low level creatinine clearance rate was observed in on-pump group. Renal function was better preserved in patients undergoing off-pump in comparison to on-pump coronary artery bypass grafting.

Introduction

Coronary artery bypass grafting is a common surgical procedure in cardiac surgery. Conventional bypass grafting using cardiopulmonary bypass has been considered as the gold standard for treatment of ischemic heart disease.¹ However, the evidence increasing that cardiopulmonary bypass may be responsible for some of the morbidity. To avoid the detritus effects of cardiopulmonary bypass, increasing interest in off-pump coronary artery bypass as a safe alternative to conventional coronary revascularization.^{1,2} The risk factors for cardiac disease like hypertension, diabetes or metabolic syndrome are also the risk factors for chronic kidney disease.² The patient with renal dysfunction requiring coronary artery bypass graft surgery represents a complex group of patients with an accelerated process of atherosclerosis have more risk to develop renal failure.^{3,4}

Post-operative renal dysfunction is a serious complication of cardiac surgery.⁵ It is associated with increase morbidity, mortality and ICU stay, particularly if require hemodialysis.^{6,7} Despite advances in cardiopulmonary bypass technology, anesthesia, per-operative hemodynamic monitoring and antibiotic therapy.^{8,9} The objective of this study was to see the renal impairment in off-pump and on-pump in patient having pre-operative impaired renal function.

Materials and Methods

Patients

This observational study was done on 50 on-pump (mean age: 57.6 ± 4.8 years) and 50 off-pump (mean age: 59.3 ± 4.1 years) who underwent elective bypass grafting. The patients were randomly selected to on-pump and off-pump group with serum creatinine levels >1.5 mg/dL and <5 g/dL.

Anesthetic technique

Induction was done with pentothal sodium, midazolam and fentanyl. The maintenance was done with isoflurane and fentanyl. Muscle relaxation ensured with pancuronium.^{5,10}

Surgical aspect on-pump technique: Median sternotomy was done. The saphenous vein and left internal mammary artery were harvested. Cardiopulmonary bypass was established with ascending aortic cannulation and a two stage venous cannulation in right atrium. The circuit was primed with 1,000 mL Hartmann's solution, 0.5 g/kg of mannitol, 7 mL 10% calcium gluconate and 60 mg heparin. The pump flow was non-pulsatile, flow rate was 2.4 L/m²/min, mean arterial pressure was 60-80 mm of Hg was maintained. The systemic temperature was kept between 34 to 36°C. The heart was arrested by using warm blood cardioplegia.¹¹ After completion of distal anastomosis, aortic cross clamp



Table I

Comparison of renal parameters in on-pump and off-pump group

Renal parameter		On-pump	Off-pump	p value
Serum creatinine (mg/dL)	Pre-operative	1.9 ± 0.3	1.9 ± 0.3	1.000
	Post-operative day 1	2.5 ± 0.4	2.1 ± 0.3	<0.001
	Post-operative day 3	2.3 ± 0.3	1.9 ± 0.3	<0.001
	Post-operative day 7	2.2 ± 0.4	1.7 ± 0.3	<0.001
	p-value	<0.001	<0.001	
Blood urea (mg/dL)	Pre-operative	45.1 ± 4.2	43.1 ± 6.9	0.083
	Post-operative day 1	61.5 ± 5.6	58.0 ± 5.7	0.003
	Post-operative day 3	57.9 ± 5.5	54.4 ± 5.0	0.001
	Post-operative day 7	52.5 ± 6.9	48.0 ± 6.1	0.001
	p-value	<0.001	<0.001	
Creatinine clearance (mL/min)	Pre-operative	59.5 ± 15.8	54.2 ± 16.0	0.098
	Post-operative day 1	34.7 ± 11.0	46.6 ± 15.4	<0.001
	Post-operative day 3	41.2 ± 15.0	53.8 ± 15.3	<0.001
	Post-operative day 7	45.2 ± 17.1	60.5 ± 14.5	<0.001
	p-value	<0.001	<0.001	

Data are expressed as mean ± SD; p value reached from unpaired Student's t-test between group and ANOVA for within group

was removed and the proximal anastomosis completed with partial clamping of the aorta. Heparin was given at a dose of 300 IU/kg and activated clotting time of 480 sec or above was maintained before commencement of cardio-pulmonary bypass.¹² The activated clotting time was monitored at 30 min interval and additional 3,000 IU of heparin was administered if needed.

Surgical aspect off-pump technique

The sternotomy was done. The saphenous vein and left internal mammary artery were harvested. The heart exposed and stabilized for the anastomosis was a combination of technique.¹³ The target artery was identified, exposed and snared with 4-0 prolene above the point for anastomosis. The coronary artery was then opened, intracoronary shunt introduced and anastomosis performed. At that time, the mean arterial pressure above 70 mm of Hg was maintained using inotropes.⁹ 100 IU/kg of heparin was used before anastomosis. The activated clotting time was 250 to 350 sec was maintained. Protamine used to reverse the effect of heparin.

Sample collection

The blood samples were collected for the estimation of creatinine and urea at pre-operatively, post-operative day 1, 3 and 7. The urine output was maintained more than 0.5 mL/kg/hour in post-operative period if needed diuretics were used.

Laboratory methods

The serum creatinine and urea levels were mea-

sured using commercial reagent kits. The creatinine clearance was calculated using the standard formula:¹⁴

Creatinine clearance (mL/min) = (140-age) x weight in kg x 0.85 / 72 x serum creatinine in mg/dL

For female patient, the result was multiplied by 0.85.

Statistic analysis

Statistical analysis was done by unpaired 't'-test, one-way ANOVA test and Chi-square test.

Results

Table I shows the comparison of renal parameters in on- and off-pump groups in pre-operative and post-operative days (day 1, 3 and 7). Serum creatinine level in case of on-pump group during pre-operative period was 1.9 ± 0.3 mg/dL which was 2.5 ± 0.4 mg/dL on post-operative day. One-way ANOVA test showed significant difference among the serum creatinine levels. Similarly serum urea level was increased from 45.1 ± 4.2 mg/dL to 61.5 ± 5.6 mg/dL. One-way ANOVA test showed significant differences.

In case of off-pump group in pre-operative serum creatinine level was 1.9 ± 0.3 mg/dL which was 1.7 ± 0.3 mg/dL on day 7 of post-operative group. One-way ANOVA test significant difference. Serum urea in pre-operative group was 43.1 ± 6.9 mg/dL which was 48.0 ± 6.1 mg/dL on day 7 of post-operative group. One-way ANOVA test showed significant difference.

Discussion

In on-pump group serum creatinine and serum urea were significantly increased in first, third and seventh post-operative day. In first day it was maximum then gradually decreased but not reached the pre-operative level. In off-pump group serum creatinine and serum urea were significantly increased in first and third day. In first day it was maximum then gradually decreased and serum creatinine reached below the pre-operative level but serum urea not reached the pre-operative level. This parameters were increased significantly first and third day after bypass grafting in both the groups which are in agreement with the findings of the studies conducted by Pramodh et al.⁵ Serum urea, and creatinine levels were significantly higher in on-pump group in comparison to off-pump group and a decrease serum creatinine below pre-operative level indicate improvement of renal function in off-pump group.^{15,16}

In on-pump group, creatinine clearance rate was significantly decreased in the first, third and

seventh post-operative day. In the first day, it was maximum then gradually increased but not reached the pre-operative level. In off-pump group creatinine clearance rate was significantly decreased in first and third day. In the first day, it was maximum then gradually increased and reached above the pre-operative level. A significant low level of creatinine clearance rate was observed in on-pump group. This finding is consistent with the finding of the study conducted by Pramodh et al.⁵ and Lin and Hwang¹⁷. It indicates that on-pump technique is more prone to develop renal dysfunction after bypass grafting.

In a prospective randomized trial of 50 patients, Ascione et al. (1999)⁸ demonstrated a slightly greater decrease in 24 hours post-operative creatinine clearance in on-pump compared with off-pump and no significant difference between pre and post-operative renal function in this study group which is not consistent with the findings of our study.

There was a significant difference among the pre-operative, first, third and seventh post-operative day which may be due to poor renal perfusion due to hypotension. Many per-operative conditions may lead to an oxygen supply and demand imbalance at the renal level such as low cardiac output state, renal vasoconstriction, hemodilution, hypotension, and loss of pulsatile flow during cardiopulmonary bypass.¹⁸ Therefore, this pathophysiological condition should be considered as one of the possible explanation for renal damage in cardiac surgery. Similar findings were evident in other studies.¹⁹ Here, our findings are partially consistent with the previous findings of Ooi et al. (2008)¹⁹ where renal function deteriorated significantly in first 4 days in on-pump group. The changes were not seen in the off-pump group. It should be noted that many studies revealed the effects of off-pump group such as hypotension, low cardiac output and dysrhythmia.²⁰

Conclusion

Renal function is comparatively better preserved in early post-operative days in off-pump technique than on-pump technique.

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