



POSTOPERATIVE RENAL FUNCTION IN THE ELDERLY VERSUS YOUNGER PATIENTS UNDERGOING ON-PUMP VERSUS OFF-PUMP CARDIAC SURGERY- A RETROSPECTIVE STUDY

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ABSTRACT Elderly patients undergoing cardiac surgery maybe at an increased risk of renal dysfunction postoperatively. In this retrospective study, we evaluated whether elderly age and on pump surgery affected postoperative glomerular filtration rate as compared to younger patients or off pump surgery. **Methods:** Data was collected from cardiac surgical patients operated between 2017-19 at our institution. Patients aged 66years and above were defined as elderly. Estimated glomerular rate was calculated using Cockcroft-gault formula over the postoperative period and analysed. **Results:** Of the 273 patients, 53 patients were elderly with average age of 71yrs with higher incidence of diabetes and hypertension. 27 elderly and 80 younger patients amongst 220 underwent off pump surgery. Duration of bypass and clamp times were less in the elderly ($p=.046$ and $p=.018$ respectively). Creatinine clearance was lower in the elderly and in those undergoing on pump surgery though not statistically significant different compared to younger patients or those undergoing off pump surgery ($p=.556$ and $p=.673$ respectively). Elderly patients had increased postoperative bleeding on pump requiring more blood transfusions. **Conclusion:** Elderly age and on pump surgery do not affect the creatinine clearance compared to younger patients or those undergoing on pump surgery in our data analysis.

KEYWORDS :

Introduction:

Increasing population mean age and access to better healthcare has increased the incidence of surgery amongst the elderly. An elderly patient is most often described as an age of 65 years or more. (1) Elderly patients are more prone to develop perioperative complications not only due to associated comorbidities but also due to the changes that occur with aging. Patients undergoing cardiac surgery are at an increased risk of developing various complications including renal dysfunction. Even minimal changes in serum creatinine that occur in the postoperative period have been associated with a substantial decrease in survival (2). The mechanism of renal dysfunction is multifactorial- hemodynamic, pharmacologic, inflammatory or other factors. Use of cardiopulmonary bypass(CPB) is associated with an increased incidence of postoperative renal dysfunction. We did a retrospective data analysis on patients having undergone cardiac surgery in the last 3 years to determine whether elderly age and use of CPB affects postoperative renal function in the form of decreased estimated glomerular filtration rate compared to younger patients and those undergoing off pump cardiac surgery.

Materials and Methods:

Data was collected on patients who underwent elective cardiac surgery at our institution between 2017 and 2019. Need for patient consent was waived off after institutional ethical committee clearance. A total of 285 case details were noted out of which 273 met the inclusion criteria. All patients aged 18 and above undergoing cardiac surgery at our centre were included in this study. Patients already on dialysis, those posted for emergency cardiac surgery were excluded from the study.

Patients were divided into 2 groups depending on age, where we defined elderly as patients aged 66yrs and above while 65years and less were defined as younger patients.

Data analysis was done using SPSS software. Cramer's V test was used for sex distribution, incidence of diabetes and hypertension amongst the groups, use of IABP and type of surgery done. Independent samples t-test was used to analyse duration of cardiopulmonary bypass and cross clamp times. Chi square test was used for use of cardiopulmonary bypass amongst the groups, the incidence of left main disease, total dose of heparin and protamine used. Anova test was used for blood products usage amongst the groups. Repeated measures Anova was used to analyse the creatinine clearance amongst the

groups over time along with the change in hemoglobin values over time.

A total of 53 elderly and 220 younger patients underwent cardiac surgery during the study period. Of the 53 elderly, 27 underwent off pump cardiac surgery, 25 had on pump surgery and 1 patient had to be converted from off pump to on pump surgery. Amongst the 220 younger patients, 80 had off pump surgery while 139 had on pump surgery and one got converted from off pump to on pump surgery($p=.069$). There was no significant difference between the groups with regards to use of cardiopulmonary bypass. Significantly higher number of elderly patients were hypertensive and diabetic. There was no difference between the groups in ejection fraction($p=.178$), incidence of left main coronary disease, the amount of heparin or protamine used amongst the groups or the need for postoperative intraaortic balloon pump as shown in table 1.

Table 1. Patient Demographics

	<66 years(n=220)	>=66 years(n=53)	p value
Sex Distribution :			.011
Males	148	45	
Females	72	8	
Hypertensive	94	34	.044
Diabetic	79	27	.005
Ejection fraction	52+/-9%	50+/-10%	.178
Preoperative cessation of aspirin(hrs)	37+/-12	35+/-12	.303
On Cardiopulmonary bypass (On pump)	139	25	.069
Off Cardiopulmonary Bypass (Off pump)	80	27	
Converted from off pump to on pump surgery	1	1	
Left Main Coronary artery disease	21	4	.651

Total Intraoperative Heparin(mg)	325+/-137	315+/-149	.619
Total Intraoperative Protamine(mg)	327+/- 135	320+/-152	.726
Postoperative IABP requirement	2	1	.540

Amongst the younger patients 138 underwent CABG, 66 underwent valve replacement, 4 had a combined CABG with valve replacement, 11 had surgery for congenital heart disease and 1 had a left atrial tumour removal whereas amongst the elderly 46 patients had CABG, 5 had valve replacement and 2 had combined CABG and valve replacement.

Table 2. Duration of cardiopulmonary bypass and cross clamp time for on-pump surgeries

	<66yrs	>= 66yrs	p value
Duration of CPB(minutes)	60+/-52	44+/-51	.046
Duration of cross clamp(minutes)	40+/-37	27+/-32	.018

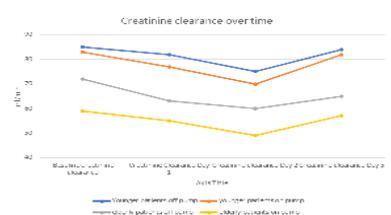
Duration of CPB and cross clamp was noted to be significantly higher in the younger patients as compared to the elderly patients (p=.046 and p=.018 respectively) as shown in table 2.

As per our institutional protocol, serum creatinine levels were obtained starting preoperatively just before the day of surgery, and then on day 1, day 2 and the day before discharge. Estimated glomerular filtration rate(eGFR) was then obtained using creatinine clearance with the cockroft-gault formula. Creatinine clearance was calculated using the formula $CCr = \frac{(140 - \text{age}) \times \text{weight}}{(72 \times \text{SCr})} \times 0.85$ (if female).

Elderly patients had lower creatinine clearance throughout the duration of stay in hospital as compared to younger patients. There was no significant difference amongst the groups with regard to change in creatinine clearance over the period of time from preoperative period to the day of discharge in each group of patients (p=.556).

Comparison of elderly patients with younger patients with changes in creatinine clearance when surgery was done on pump or off pump showed that there was no significant difference between the groups (p=.673).

Figure 1. Calculated Creatinine Clearance amongst patients over time



There was a significant fall in hemoglobin in the elderly patients as compared to the younger patients (p=.022). Elderly patients operated on pump had a higher requirement of packed red cell transfusions than younger patients or those that were done off pump (p=.023) but there was no clinically significant difference in fresh frozen plasma usage (p=.619). Usage of platelets was noted to be higher in the elderly patients as compared to the younger patients (p=.022).

Table 3. Usage of blood products.

	<66years(n=220)	>=66years(n=53)	p value
Total packed red blood cell usage			.023
Off-CPB	0.94+/-1	0.96+/-0.9	
On-CPB	1.7+/-1.3	2.6+/-1.5	
Total Fresh frozen plasma usage			.619
Off-CPB	0.87+/-1.1	1.2+/-1.5	
On-CPB	1.9+/-1.7	1.8+/-1.6	
Total Platelet usage	0.59+/-1	1.1+/-1.5	.022

There was no significant difference between the groups with regards to the duration of stay in the intensive care unit (2.5+/-0.8 vs 2.5+/-0.7;

p=.723) or in the hospital (5.4+/-0.9 vs 5.6+/-0.9; p=.366 respectively).

Discussion:

Our study shows that postoperative creatinine clearance is not affected by age or use of cardiopulmonary bypass in patients undergoing cardiac surgery as compared to younger patients or those undergoing on pump surgery.

There have been no studies comparing the effects of cardiopulmonary bypass on postoperative creatinine clearance in elderly patients compared to younger patients. Significant fall in postoperative creatinine clearance causing acute kidney injury occurs in 1% of all patients undergoing general surgery and is associated with 8-fold rise in 30-day mortality. (3). There is an approximate 30% incidence of acute kidney injury in patients undergoing cardiac surgery mainly due to the associated comorbidities in this set of patients and causes a five-fold rise in postoperative mortality. Postoperative development of renal dysfunction has not only been associated with a rise in immediate postoperative mortality but also a rise in long term mortality in patients undergoing cardiac surgery. (4)

CPB has been associated with significantly increased risk of acute renal failure following cardiac surgery even though there is a slight fall in serum creatinine perioperatively due to haemodilution, volume therapy, and blood loss. (5) In a retrospective data analysis in patients with normal preoperative renal function, 2.9% of the on-pump group and 1.4% in the off-pump group developed acute renal failure (p=.031). (6) These results were similar to a randomised controlled trial comparing on pump versus off pump CABG which concluded that off pump surgery offered better renal protection. (7). The average age in this study was 61+/-3.7 yrs. Even though creatinine clearance was improved initially in the on-pump group, it reduced significantly on day 1 and 2 post surgery whereas in our study, we did not find any significant differences in creatinine clearance over the postoperative period. Off pump cardiac surgery is noted to offer better patient outcomes in non-dialysis dependent renal dysfunction patients.

Maintenance of intraoperative hemodynamics with adequate renal perfusion, avoidance of nephrotoxic drugs, systemic inflammatory response and a shorter duration of cardiopulmonary bypass may help in reducing the risk of perioperative renal dysfunction and renal failure when using cardiopulmonary bypass. An observational study by Bove et al noted that optimising cardiac output and minimising CPB times could improve outcomes in patients with high risk of developing acute renal failure. (8) In our study, elderly patients had significantly lesser bypass times and cross clamp time explaining the insignificant difference on postoperative creatinine clearance between the groups.

Use of creatinine clearance rather than serum creatinine levels for predicting risk of perioperative acute renal failure has been validated by multiple studies. Creatinine clearance less than 60ml/min may predict risk of AKI in at least 10% of the surgical population. (9, 10) Jang et al in a retrospective cohort analysis on cardiovascular surgery patients noted that almost 15% of the patients had major postoperative complications and complication rate increased as the eGFR reduced. eGFR was noted as a better predictor than serum creatinine for postoperative complications. (11)

The rate of creatinine elevation in the elderly is much slower than that of the general population, leading to an artificially late diagnosis of AKI. (12) In our study, none of the patients developed severe postoperative renal dysfunction needing further treatment over their postoperative period of hospital stay.

Even though elderly patients are at an increased risk for perioperative complications, certain studies have shown that even octogenarians can undergo cardiac surgery successfully with improved symptoms, functional status and quality of life. (13) Some of the studies on octogenarians have shown that these patients are at an increased risk of postoperative renal failure as compared to septuagenarians (14) or those undergoing off pump surgery among octogenarians (15). In our study, the average age of elderly patients was 71 years with the oldest being 83 years and younger patients had an average age of 53 years.

Patients developing acute renal failure with an eGFR less than 60ml/min after CABG have a higher risk of mortality as compared to those with a higher postoperative eGFR. (17) eGFR has better

prognosticating ability than serum creatinine and is an important determinant of long-term survival after CABG. (18)

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