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ORIGINAL ARTICLE

Association of long duration of cardiopulmonary bypass with adverse outcomes in patient undergoing coronary artery bypass grafting.

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ABSTRACT… Objective: To investigate the association between long duration of cardiopulmonary bypass and various adverse postoperative outcome in patients undergoing coronary artery bypass grafting for coronary artery disease. **Study Design:** Cohort study. **Setting:** Department of Cardiac Surgery, Azra Naheed Medical College, Lahore. **Period:** January'2023 to June'2023. **Methods:** Non-probability consecutive sampling done for 180 cases; 90 cases in each group is calculated with 80% power of test, 5% level of significance and taking expected percentage of ARF i.e. 1.3% in patients having short duration of surgery while 12.5% in patients having long duration of surgery. The in-hospital mortality in two groups was 2% vs. 12.9% (p=<0.001) exposed vs non-exposed. **Results:** According to study renal failure and mortality was significant among patients who had longer bypass time. According to chi square test p value was 0.014 with high significance of renal failure in group 46-75years and strong association of Age with ARF RR of 2.16. According to chi square test p value was 0.039 in male group with high significance of mortality in 27-30 BMI group and strong association of gender with mortality RR of 6.3. **Conclusion:** Longer CPD in patients undergoing CABG significantly associated with increased risk of postoperative renal failure and mortality. Key risk factors include Age >46 years and Male gender with BMI 27-30. Prolonged bypass time should be considered a predictor of adverse outcomes, warranting closer monitoring in high-risk patients.

Key words: Acute Renal Failure, Body Mass Index, Cardiopulmonary Bypass Time, Cardiac Surgery, Coronary Artery Bypass Grafting, In-Hospital Mortality, Postoperative Mortality, Risk Factors, Relative Risk, Serum Creatinine.

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INTRODUCTION

Coronary artery bypass grafting (CABG) is conventional and gold standard treatment for patients having coronary artery disease.[1,2] Cardiopulmonary bypass machine (heart lung machine) is the miracle of new age which made cardiac surgery possible but at the cost of its adverse effects on human body.[3,4]

Once bypass is established human blood is directly exposed to cardiopulmonary bypass circuit which can induce severe allergic reactions and can cause complications involving brain, kidneys, lungs and GIT.[5-7] The duration of time in which patient remains on heart lung machine is known as cardiopulmonary bypass time (CPB). Prolonged CPB time increases the chances of harmful Effects and complications. Bypass time is one of the major periprocedural factor determining patient outcome.[8-10]

AKI following coronary artery bypass grafting (CABG) is a common complication with high morbidity and death. AKI is linked to cardiopulmonary bypass (CPB).[11] Acute kidney damage affects up to 30% of coronary artery bypass grafting patients, depending on criteria. Kidney injury increases the risk of infectious complications, short-term and long-term mortality, and hospital problems. In addition to preoperative renal impairment, peripheral artery disease, diabetes, and age, cardiopulmonary bypass technique and duration are risk factors for AKI.[12]

In a study, it was noticed that ARF was higher in long duration of CPB as compared to short duration i.e. 1.3% vs. 12.5% (p=0.018). The in-hospital mortality in two groups was 2% vs. 12.9% (p=<0.001).[14]

Rationale of this study was to find the association between long duration of cardiopulmonary bypass

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and adverse postoperative outcomes in patients undergoing coronary artery bypass grafting. Literature has showed that longer duration of cardiopulmonary bypass is associated with post-operative complications and even may lead to mortality within 5-7 days after surgery, which are usually in-hospital stay. Though international studies are there but data reflecting our population is not available and there is only one study found in literature which showed significant results. This study will help us generating information as well as enable us to confirm the evidence in local population.

METHODS

The cohort research was conducted in the department of cardiac surgery at the Azra Naheed Medical College, Lahore, more than six months (from January'2023 to June'2023) after the synopsis was approved from the CPSP and Ethical Review Board (ANMC/ME/01/23/058, Dated: 04-January-2023 in the name of Dr M. Ammar). The expected percentage of ARF is 1.3% in patients with a brief duration of surgery and 12.5% in patients with a long duration of surgery, as determined by non-probability consecutive sampling of 180 cases. The power of the test is 80%, the level of significance is 5%, and the number of cases in each group is 90. The in-hospital mortality rate was 2% in the exposed group and 12.9% in the non-exposed group (p=<0.001). Selection Criteria:

Patients of either gender who are scheduled to undergo coronary artery bypass grafting (CABG) for coronary artery disease under general anesthesia will be included in the study. The age range is 40 to 70 years. Group A will consist of patients who are undergoing surgery with a short cardiopulmonary bypass (CPB) duration (non-exposed), while Group B will consist of patients who are undergoing surgery with a long CPB duration (exposed). Therefore, the study population will be divided into two categories.

If the medical record indicates that the patient is undergoing CABG in conjunction with any additional procedure, such as for valvular disease, they will be excluded. Additional exclusion criteria include a left ventricular ejection fraction (LVEF) of less than 30% on echocardiography, intraoperative technical difficulties resulting in a bypass time exceeding 240 minutes, and preoperative renal impairment or a serum creatinine level greater than 1.2 mg/dL.

Demographic information, including name, age, gender, BMI, diagnosis, and baseline creatinine level, was also recorded. Patients were transferred to the intensive care unit following surgery and will be monitored there. A 3cc BD syringe will be used to collect a blood sample, which will be sent to the hospital's laboratory for the evaluation of the basal creatinine level following the surgery. A rise in creatinine was observed. ARF was classified as such if the absolute increase in serum creatinine was 0.3mg/dl or greater, and the urine output was decreased, as per the operational definition. Then, patients were monitored until their discharge. In-hospital mortality was designated for patients who passed away within 30 days of surgery. The proforma was used to record all of this information.

We entered all the data into SPSS version 21 and looked at it. Mean and standard deviation were used to show quantitative factors like age, BMI, and a rise in blood creatinine. Qualitative characteristics including gender, ARF, and death in the hospital were shown as percentages and frequencies. We looked at ARF and in-hospital death rates in both groups and figured out the proportional risk. A relative risk of more than 1 was seen as important. The data was broken down by age, gender, and BMI. We used the post-stratification chi-square test and found that a p value of less than 0.05 was significant.

RESULTS

In this study, 72.8% of the patients were male (131) and 27.2% were female (49). There was no statistically significant difference (p>0.05) between the two groups for most of the factors, such as height and age. Patients in Group B, who had longer bypass times, had a higher BSA (1.71±0.17) (p<0.05) than patients in Group 1, who had shorter bypass times (1.67±0.27). Also, the people in Group B, who had longer bypass times, weighed more (65.88±12.1) (p<0.05) than the people in Group 1, who had shorter bypass times (64.41±17.51). The research of body mass index found significant differences between the two groups: group A had a value of 24.9±1.83 and group B had a value of 25.7±2.12 (p value 0.016). Group B had a higher

BMI. Table-I summarizes perioperative variable like bypass time and postoperative variables were urine output, serum creatinine levels and mortality.

TABLE-I

Perioperative and postoperative variables

Variables	Group-1	Group-2	Overall
	Mean ± SD	Mean ± SD	Mean ± SD
Serum creatinine (mg/dl)	1.00±0.24	3.32±1.38	1.16±0.63
Mortality	1.00±0.00	1.05±0.23	1.05±0.21

Bypass time calculated in minutes in group 1 was (61.1±18.49) and group 2 showed results with wide variation (120.68±33.09) with overall mean of 90.25 min± 39.3

Renal failure was more common in group with longer bypass time. Among males 48.8% were in group A with a frequency of 61 and 51.2% were in group B with a frequency of 64. Males in group A had low incidence of renal failure of only 9.8% with frequency of only 6. Whereas incidence of renal failure among males in group B was significant 78.1% with frequency of 50. On the other hand among females 59.1% were in group A with frequency of 29 and 40.8% were in group B. Females in group A showed lesser incidence of renal failure 13.7%with frequency of 4 while group B had significant result of 70% with frequency of 14. Group stratification showed renal failure in group B was more common in age ranging 45-60 years highest from 55-60 years. The serum creatinine levels of the patients having higher values of bypass time (Group-2) were greater (3.32±1.38) ($p<0.05$) than in group-1 (1.00±0.24) that had shorter bypass time values. Relative risk calculated for above mentioned results is 6.9, showing longer bypass time to be a strong risk factor for postoperative renal failure.

In group A 34 out of 90 candidates had ARF whereas in group B 71 out of 90 patients had ARF. According to chi square test p value was 0.001 with high significance of renal failure in group B and strong association of long bypass time with ARF RR of 2.1 Group stratification on age for ARF age group 46-75 years had 91 out of 124 candidates had ARF whereas in group 30-45 years 29 out of 56 patients had ARF. According to chi square test p value was 0.014 with high significance of renal failure in group 46-75years and strong association of Age with ARF RR of 2.16.

Group stratification on gender for ARF male group 90 out of 131 candidates had ARF whereas in Female group 30 out of 49 patients had ARF. According to chi square test p value was 0.001 in male group with high significance of renal failure in male group and strong association of gender with ARF RR of 2.04 Group stratification on BMI for ARF 23-26 group had 29 out of 80 candidates had ARF whereas in 27- 30 group 91 out of 100 patients had ARF. According to chi square test p value was 0.02 in male group with high significance of mortality in male group and strong association of gender with mortality RR of 1.48. Hence high BMI have clear association with acute renal failure.

Hence analysis showed that bypass time proved to be significantly associated with higher postoperative serum creatinine levels and justified the objective of study.

TABLE-II

Comparison between both groups for ARF

	ARF		Total	P-Value	RR
	No	Yes			
Group A	41	49	90		
Group B	19	71	90	0.001	2.15
Total	60	120	180		

The mortality among patients having higher values of bypass time (Group-2) was greater (1.05±0.23) ($p<0.05$) than in group-1 (1.02±0.00) that had shorter bypass time values. There were 2 mortalities among females and 9 mortalities among males. 9 mortalities belonged to group B.

In group A 2 out of 90 candidates had mortality whereas in group B 9 out of 90 patients had mortality. According to chi square test p value was 0.02 with high significance of mortality in group B and strong association of long bypass time with mortality RR of 4.50. Group stratification on age for Mortality age group 46-75 years had 6 out of 124 candidates had ARF whereas in group 30-45 years 5 out of 56 patients had ARF. According to chi square test p value was 0.006 with not a significance result of mortality among two groups. Though relative risk

calculation showed strong association of Age with ARF RR of 5.61

Group stratification on gender for Mortality male group had 8 out of 131 candidates had ARF whereas in Female group 3 out of 49 patients had ARF. According to chi square test p value was 0.037 in male group with high significance of mortality in male group and strong association of gender with mortality RR of 6.4.

Group stratification on BMI for mortality 23-26 group had 3 out of 85 candidates had mortality whereas in group 8 out of 95 test p value was 0.039 in male group with high significance of mortality in 27-30 BMI group and strong association of gender with mortality RR of 6.3. Therefore, it also showed that higher bypass time was associated with mortality and it is an important risk factor.

TABLE-III

Comparison between both groups for mortality

	Mortality		Total	P-Value	Relative Risk
	No	Yes			
GROUP A	88	2	90		
GROUP B	81	9	90	0.02	4.50
Total	169	11	180		

DISCUSSION

According to data analysis preoperative parameters like age, gender did not show any significance, but weight and body surface area had significant relation with postoperative adverse outcome. Weight of the patients having higher values of bypass time were higher than in group-1 that had shorter bypass time values. Weight and body surface area are associated with adverse outcome.

Patients in group-2 had significant renal failure. They showed rise in serum creatinine levels postoperatively and slow recovery. Drop in urine output was also significant in patients with longer bypass time. On other hand group-1 had low incidence of serum creatinine levels rise.

According to one international study by Fischer UM, Weissenberger WK, Warters RD[15] done in 2002 showed significance of CPB time with renal failure. In above mentioned study ARF group requiring postoperative dialysis, CPB duration was longer (166 +/- 77 [standard deviation, SD] min) compared to CREATININE group showing renal dysfunction had CPB time (115 +/- 41 min; $p < 0.001$) compared to Control groups who had no renal dysfunction had CPB time (107 +/- 40 min; $p < 0.001$).

Another study done in 2007 by Taniguchi, Souza AR, Martins AS[13] showed very significant results supporting longer CPB time to be strong predictor of post op rise in creatinine levels. The median increases in serum creatinine were 0.18 + 0.41(CPB<70min) and 0.42 + 0.44 (CPB>90min p=0.005). Dialysis was indicated in 1.3% (CPB<70min) and 12.5% 90min - p = 0.018).

Another study by Tolpin D, el. al.[16], emphasized high 30 days mortality among patients who had renal failure after long CPB time. Results of study stated that negative change in serum creatinine was associated with reduced 30-day all-cause mortality. Even subclinical increases in serum creatinine were associated with increased mortality relative to patients with negative changes in serum creatinine (odds ratio, 3.93; 95% confidence interval, 1.68-9.22; P < .01). After propensity matching, subclinical increases in serum creatinine were still associated with increased mortality (odds ratio, 4.13; 95% confidence interval, 1.37-12.45; P = .01).

According to our study Bypass time calculated in minutes in group 1 was (61.1±18.49) and group 2 showed results with wide variation (120.68±33.09) having The serum creatinine levels of the patients having higher values of bypass time (Group-2) were greater (3.32±1.38) ($p<0.05$) than in group-1 (1.00±0.24) that had shorter bypass time values. Bypass time had significant impact on postoperative parameters like urine output and mortality. Postoperative renal failure is one the most important indicator of postoperative recovery of the patient.

It was observed in this group of patients had longer time towards recovery, respiratory failure and arrhythmias. There are number of studies available that have shown renal failure to be important factor determining patients recovery after cardiac surgery. Most of studies compared preoperative factors and

postoperative outcomes. I have studied association of intraoperative parameter with postoperative outcome. The results of our research are sufficiently convincing and demonstrate the direct impact of bypass time on renal function and mortality. The incidence of renal failure and mortality is significantly higher in the group with a longer bypass time.

CONCLUSION

Cardiopulmonary bypass time is an intraoperative variable that is both objective and easily accessible. It has a direct and robust correlation with mortality and morbidity. This is due to two factors. CPBT is indicative of certain unforeseen occurrences, such as technical difficulties in revascularization that result in a longer CPBT or issues with weaning from bypass. Simultaneously, cardiopulmonary bypass has a time-dependent impact on the human organs(organism). It induces a systemic inflammatory response by activating complement pathway and injuring platelets, which becomes more severe as CPBT is prolonged.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Taimoor Khan:** Data collection, Paper Writing
2	**Mohsin Shabbir:** Paper writing.
3	**Muhammad Ammar:** Data analysis.
4	**Zafar Tufail:** Review of Manuscript.
5	**Awais Hussian Kazim:** Review of manuscript.
6	**Shahryar:** Review of manuscript.