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IMPACT OF CROSS CLAMP DURATION ON POSTOPERATIVE VENTILATORY AND INOTROPIC REQUIREMENTS IN CABG PATIENTS

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Abstract

Background:
Ischemic heart disease is one of the major causes of mortality and disability worldwide. CABG is the definitive surgical treatment to relieve symptoms and to improve survival of the patients. Aortic cross clamping is the pivotal step of the surgery in which aorta is deliberately occluded, thus temporarily halting the systemic blood flow. Cross clamp time (CCT) is regarded as the important factor that can influence patient's postoperative outcomes.

Aim of the study:
To determine the impact of cross clamp time on postoperative mechanical ventilation duration and inotropic support requirements in CABG patients.

Methodology:
This comparative cross-sectional study was conducted at Cardiac Surgery Department of Punjab Institute of Cardiology, Lahore. This study included 100 patients undergoing CABG with CPB. Independent t test and chi square test were used to investigate associations.

Results:
A total of 100 patients were included, out of which 85 (85%) were male patients. The mean age (years), height (cm) and weight (kg) were 54.86 ± 9.48 years; 165.94 ± 8.76 and 72.32 ± 2.76, respectively. Baseline risk factors were comparable between groups with their non-significant p-values. The difference in mean aortic cross clamp time between the two groups was significant (38.10 ± 7.03 vs. 66.98 ± 12.90 minutes) p<0.001. No significant difference was observed in postoperative ejection fraction between both groups (p=0.47). However, prolonged CC time was significantly associated with increased postoperative inotropic support (p=0.04), without a corresponding increase in mechanical ventilation duration (p=0.71).

Conclusion:
Our study concluded that prolonged cross clamp time correlates with the increased need of inotropic support postoperatively. However, it does not result in increased demand for mechanical ventilation support.

INTRODUCTION

Coronary artery disease is one of the major causes of mortality and disability worldwide.[1] It is disease of arteries which supply blood flow to the heart muscle that become blocked or narrowed due to atherosclerotic plaque.[2] So, the insufficient oxygen supply to the heart

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muscle does not meet its need, resulting myocardial infarction.[3] Coronary artery disease (CAD) presents a range of symptoms that may vary significantly among individuals. The most common manifestation is chest discomfort often described as angina, which can be accompanied by other symptoms including fatigue, weakness, shortening of breath, unusual symptoms like epigastric discomfort. Understanding these symptoms is crucial for early diagnosis and management.[4] CAD is treated by PCI and CABG. Coronary Artery Bypass Grafting is a surgical procedure in which an alternative pathway is made for the oxygenated blood flow to bypass the blocked vessel. This is done by the using an artery most commonly IMA or radial and vein i.e., saphenous vein.[5] Modern CABG with CPB is successful but it may cause myocardial damage, respiratory failure, bleeding disorders, altered liver function and renal function and neurological changes.[6] During CPB, after the harvesting of vessels for grafting, cross clamp is applied to provide dry surgical field that facilitates surgeons to perform complex procedures with accuracy and constant blood flow to the body is supplied by the pump. Despite using different measures like cold, warm, tepid cardioplegia to reduce ischemic insult, these efforts are sometimes insufficient.[7] It is believed to cause myocardial damage due to prolong ischemia, inflammation, reperfusion injury, endothelial damage.[8] This may lead to increase use of inotropic support postoperatively.[3] In case of severe myocardial damage, there might be difficulty in weaning from bypass, inotropic support and intra-aortic balloon pump may be utilized to achieve adequate cardiac output. It is believed that patients undergoing CABG with prolong aortic cross clamp time is associated with postoperative complications.[9] Inflammatory response associated with the CABG is one of the major causes of respiratory dysfunction postoperatively, demanding prolonged mechanical ventilation time. The longer CBP time, the more probability that there will be more complications. Patients with preserved ventricular function tolerate ischemic times better than the patients with impaired ventricular function.[10] Understanding the importance of cross clamp duration on postoperative ventilatory and ionotropic requirements is essential to optimize the patient outcomes and help the clinicians in managing pre and intra operative strategies for patient care.[5] Limiting the cardiac arrest time, lowering temperature to reduce metabolic activity, can facilitate in rapid recovery of patients. Meanwhile there are insufficient evidence to support the relation between cross clamp time and postoperative mortality and morbidity.[11] The aim of the study is to investigate whether the prolonged aortic cross clamp time in patients undergoing CABG would be associated with high postoperative ionotropic support and prolong mechanical ventilation time or not.

METHODOLOGY:

A comparative cross sectional study was conducted at Cardiac Surgery Department of Punjab Institute of Cardiology, Lahore in the duration of 6 months from 1st February, 2025 to 31st July, 2025. A total of 100 patients were successfully enrolled by adopting a non-probability consecutive sampling technique who fulfilled the predefined inclusion and exclusion criteria after receiving informed consent. Inclusion criteria involved patients of both genders who underwent cardiopulmonary bypass with central sternotomy. Patients who had CABG with valvular surgery, off pump procedures, emergency and redo surgeries, patients undergoing minimal invasive cardiac surgery (MICS) and those with chronic lung diseases and other significant comorbidities were also excluded.

Patients were assessed preoperatively by taking their history which include age, gender, weight and height for BMI, hypertension (HTN) and diabetes Mellitus (DM). History of smoking was also taken for assessing respiratory function. Full physical examination of each patient was also performed. Intraoperative variables such as duration of aortic cross clamping was carefully recorded for each patient. Patients were then assessed postoperatively for mechanical ventilatory requirements and ionotropic support, myocardial and pulmonary function from intensive care unit. In this study the use of noradrenaline on the day 1 was considered

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as the inotropic support of the patient. Our study population was divided into 2 groups based on the aortic cross clamp time during CABG.

Group A: included patients who underwent CABG with aortic cross clamp time less than 50 minutes.

inotropic support were expressed as numbers and percentages while the quantitative variables including age, ejection fraction, ventilation time, cross clamp time were presented as mean and standard deviation. Statistical analysis between two groups of qualitative data was done by using Chi square test but in case of expected count in any cell less than 5, we used

Group B: included patients who underwent CABG with aortic cross clamp time of 50 minutes or longer.

Data were collected, revised analyzed by using Statistical Package for Social Science (IBM SPSS) version 27. The qualitative variables including gender, diabetes mellitus, smoking, Fischer test. To determine the association between quantitative data of two groups, Independent sample t-test was used. The margin of error was set to 5% and confidence interval was set to 95%. So, the *p*-value < 0.05 were considered significant.

RESULTS

In this study, data of total 100 participants were enrolled. The mean age (years) and standard deviation were 54.86 ± 9.478 with minimum and maximum ages of 29 years and 85 years respectively. Out of 100 patients 85 were male patients and 15 were female patients. Total 100 patients had mean age 54.86 years and standard deviation 9.478 ranging from 29 to 85 years

Gender	**Male**	85
	Female	15
Age	**Mean**	54.86
	Standard deviation	9.47
	Maximum	85
	Minimum	29
	Total	100

Table 1: Descriptive statistics of age and gender

GroupA included data of patients having cross clamp time less than 50 minutes while Group B patients had cross clamp time greater than or equal to 50 minutes. The mean age (years) of group A and group B was 55.64 ± 9.484 and 54.86 ± 9.504 respectively. Out of total 85 male patients, 39(78%) patients were from group A and 46(92%) patients were from group B. Additionally, group A included 11 female patients while group B comprised 4 female patients. The mean height and weight of patients in both groups are represented in Table 2.

Groups	**Height (cm)**	**Weight (kg)**
	Mean ± SD	**Mean ± SD**
Group A	166.12±9.11	71.76±12.21
Group B	165.76±8.30	72.88±13.39
Total	165.94±8.67	72.32±12.76

Table 2: Comparison of weight and height between the two studied groups

Comparing the comorbidities in both groups using chai square test revealed differences between two studied groups. There were no statistically significant differences noted in the prevalence of diabetes (p = 0.23), hypertension (p = 0.84) and smoking (p = 0.40). the descriptive statistics of risk factors in both groups are represented in Table 3

Frontier in Medical & Health Research

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Risk factors		Group A	Group B	*p*-value
Diabetes	Yes	20 (40%)	26 (52%)	0.23
	No	30 (60%)	24 (48%)	
Hypertension	Yes	23 (46%)	22 (44%)	0.84
	No	27 (54%)	28 (56%)	
Smoking	Yes	15 (30%)	19 (38%)	0.4
	No	35 (70%)	31 (62%)	

Table 3: Comparison of comorbidities between the studied groups

Group A with mean and standard deviation of aortic cross clamp time 38.10 minutes and 7.03 respectively; its values ranging from 24 to 49 minutes while Group B with mean and standard deviation of 66.98 ± 12.91 minutes; values of cross clamp time in this group ranging from 51 to 106 minutes. Comparison between two groups regarding CCT using independent *t*-test revealed statistically significant difference with *p*-value <0.001 as shown in the Table 4

CCT (minutes)	Group A	Group B	*p*-value
Mean ± SD	38.10 ±7.03	66.98 ±12.91	<0.001
Range	24-49	51-106	

Table 4: Comparison of CCT between the studied groups

Patients of group A had mean ejection fraction (%) 51.08±10.08 SD, whereas patients of group B had mean ejection fraction 49.60±10.19 SD. Comparing both groups on this basis by using independent *t*-test with statistically insignificant *p*-value of 0.47, it means it has no effect on results. Out of 100 patients, 48 patients received inotropic support (post-operative) from which 19 (38%) patients belong to group A in while 29 (58%) patients belong to group B with *p*-value of 0.04 which is statistically significant. Comparison between studied groups regarding patients required inotropic supports postoperatively are represented in the Table 5

Groups	Inotropic support		*p*-value
	Yes	No	
Group A	19 (38%)	31 (62%)	
Group B	29 (58%)	21 (42%)	
Total	48	52	0.04

Table 5: Comparison of inotropic support requirements between the studied groups

Group A exhibited mean duration of mechanical ventilation time 8.38±10.67 ***hours*** vs 9.18±10.99 ***hours*** compared to Group B with *p*-value 0.71 which is statistically insignificant. Comparison between studied groups regarding mechanical ventilation duration are displayed in the Table 6

Groups	Mechanical Ventilation time (hours)	*p*-value
Group A	8.38±10.67	
Group B	9.18±10.99	0.71

Table 6: Comparison of mechanical ventilation duration between the studied groups

Frontier in Medical & Health Research

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Comparison of all clinical variables studied in this study are represented in the Table 7.

Clinical variables		Group A	Group B	*p*-value
Ejection fraction (%)		51.08±10.08	49.60±10.19	0.47
CCT (minutes)		38.10±7.03	66.98±12.91	<0.001
Ventilation time (hours)		8.38±10.67	9.18±10.99	0.71
Inotropic support	Yes	19 (38%)	29 (58%)	0.04
	No	31 (62%)	21 (42%)	

Table 7: Summary of clinical variables among the studied groups

DISCUSSION

This study was conducted on 100 patients who underwent on pump cardiopulmonary bypass surgery to investigate the impact of intraoperative factor that is cross clamp time on postoperative inotropic and ventilatory requirements. This study focused on the hypothesis that the ischemic period during the surgery affect the postoperative patient outcomes. By optimizing the intraoperative factors, quality of patient care and resource utilization can be improved. In this study after considering the inclusion and exclusion criteria total 100 patients were enrolled, of whom 85% were male and 15% were female. The study population was divided into two groups based on cross clamp time with 50 in each group. The comparison of demographic data between two studied groups with statistically insignificant p-values, thereby suggesting that these factors are well balanced between two groups and have no influence on the outcomes of the study being conducted. The preoperative comorbidities of patients including hypertension, diabetes and smoking status were analyzed and compared between two groups. The results demonstrated no statistically significant differences in the prevalence of these risk factors; hypertension (40% vs. 52%) with p-value 0.84, diabetes (46% vs. 44%) having p-value 0.23, smoking (30% vs. 38%) with p-value 0.40. Ejection fraction of the patients was also found statistically insignificant, thus left ventricular function was well balanced between two groups reducing the risk of cofounding biases.

The significant difference in cross-clamp time between the two groups provides insight into its association with postoperative outcomes, specifically the need for inotropic support and mechanical ventilation. In terms of postoperative variables, there was significant difference noted between two groups for the need of inotropic support postoperatively, having statistically significant p-value 0.04. This finding suggests that CCT has a significant effect on postoperative requirement of inotropic support. Increase in aortic cross clamp time and patient's ischemic time increase the chances of low cardiac output syndrome, having adverse outcome on patient's recovery postoperatively. In this study, the comparison of mechanical ventilation time between two groups revealed statistically non-significant differences, *p*-value 0.71, suggested that other perioperative factors such as patient comorbidities, intraoperative management, and anesthetic protocols may have greater impact on the duration of postoperative mechanical ventilation support. Total 70 percent of patients extubated earlier within 8 hours of the time when the patient had been shifted from operation theater to ICU. Only few patients had ventilation time of up to 2 or 3 days.

This study had few limitations. It was conducted at a single center, which may limit the generalizability of the findings to other hospitals, regions, or healthcare settings with different patient populations, resources, or clinical practices. As a result, the applicability of these results to a broader population remains uncertain. Additionally, the study had a relatively small sample size, which reduces the statistical power and may limit the ability to detect significant associations or differences between groups. Future studies should incorporate multi-center trial to confirm and extend these results. This study also did not include mortality cases because of existing comorbidities.

The results of this study provide a comprehensive approach to understanding the impact of cross clamp time and contribute evidence-based findings to support clinical

Frontier in Medical & Health Research

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decision making. Maximizing the efficiency of intraoperative factors can improve quality of patients care and reduce the overall burden on resource utilization.

The results of current study corroborate the findings of cited study.[12] They concluded that longer aortic cross clamp was directly related to increase in demand of inotropic support postoperatively. Patient with prolong aortic cross clamp time were significantly required more inotropic support, with the highly significant *p*-value <0.001.

In accordance to Osama *et al.*,[3] significant differences were founded between two groups regarding inotropic support of the patients postoperatively. Patients with prolong aortic cross clamp time required increased dose and duration of inotropic support with significant p-value 0.04. From Group A (prolong aortic cross clamp time patients) 80.4% patients needed inotropic support compared to Group B (less aortic cross clamp time patients) 62.8% patients required support while there were significant differences between two groups regarding duration of mechanical ventilation (significant *p*-value 0.034), contrary to the findings of current study related to postoperative ventilation support.

These findings are consistent with study of Paracha *et al.*, in which they found no statistically significant relation between cross clamp time and mechanical ventilation time, having insignificant p-value 0.08. Mean and SD of ventilation time of Groups A and Group B were 3.80±0.86 hours and 5.17±5.43 hours respectively. In contrast a study[7] demonstrated that mechanical ventilation time is directly related to increased cross clamp time. They found that early extubated patients (30%) had mean cross clamp time 52.6±12 minutes while the patients with mean cross clamp time 68.8±48 minutes were extubated lately with statistically significant *p*-value <0.001.

Another study[8] showed that troponin I levels were evaluated postoperatively, showed patients with CCT>70 minutes had troponin I levels 7.1±2.1 while patients with CCT<40 minutes had troponin I levels 1.9±2.1. They clearly mentioned that aortic cross clamp time is directly proportional to increase in myocardial damage showed by increase in postoperative troponin I level in CABG patients.

Prolonged cross clamp time has negative effect on myocardial and ventilation function. However, an exact threshold of cross clamp time has yet to be determined. They proposed 50 minutes of cross clamp time as a practical safety limit.[13]

CONCLUSION:

In the current study, the findings revealed significant difference in the need of inotropic support postoperatively between two groups while the mean duration of mechanical ventilation between two groups was similar, with no statistically significant disparity. It is concluded that prolonged cross clamp times correlate with the increased need of inotropic support postoperatively. However, it does not result in increased demand for mechanical ventilation support.

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