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ORIGINAL ARTICLE

Effect of Shorter Cross Clamp Time vs. longer Cross Clamp time on cardiac enzyme levels in patients of CAD undergoing CABG

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ABSTRACT

Aim: To compare mean cardiac enzyme levels in of shorter cross clamp time V/S longer cross Clamp time in patients undergoing CABG in local population.
Study Design: Randomized Controlled Trial
Place and duration: This study was performed from 2nd April 2020 to 2nd October 2020 in the Department of Cardiac Surgery Punjab Institute of Cardiology, Lahore.
Methodology: After informed consent, all patients undergoing CABG were enrolled and divided into two groups. A predesigned performa was used to enter preop, intra op and post op variables and cardiac enzyme levels were compared between shorter (<60 minutes) and longer (>60 minutes) aortic cross clamp time groups.
Results: Study had enrolled 300 patients and 150(50%) patients were designated group A (shorter cross clamp time and 150 (50%) patients were designated in group B (longer cross clamp time). Out of these 300, 246 patients (82%) were males and 54 (18%) were females. Extremes of age were 70 years and 37 years and mean age was 56.77±8.03 years. Group A (shorter cross clamp time) patients had mean age of 56.64 ±7.53 and group B (longer cross clamp time) patients had 56.89±8.52 .Mean EF (%) was 52.17±8.98 with 23% being minimum and 70% being maximum. In group A patients, 93 patients (62%) were hypertensive , 82(55%) were smokers and 67 (45%) patients were diabetic, while group B had 110 (73%) hypertensive, 84(56%) smokers and 73(49%) diabetic patients. Mean CPB time in group A was recorded to be 93.72±29.97 and mean CPB time in group B was 121.04±31.83. The P-value was 0.001, significant enough to represent difference in CPG time in both groups
Practical Implication: Additionally, no notable difference was found in need of inotropic supports between two groups. Longer cross clamp time is also associated with longer CPB time which in turn correlates with higher morbidity and mortality.
Conclusion: It is concluded that prolonged cross clamp time is an independent predictor of morbidity despite cardio protection by modern strategies
Keywords: CKMB, IABP, CABG, CPB time, aortic cross clamp time, Shorter Cross

INTRODUCTION

In medical contexts, cross clamp time refers to the duration during which a blood vessel, typically an artery, is clamped shut using a surgical instrument.[1,2] Shorter cross clamp time, therefore, refers to a reduced duration of clamping. The effects of shorter cross clamp time can vary depending on the specific context, but some potential effects. [3,4]Reduced ischemic damage: Cross clamp time can impact the amount of ischemic (lack of blood flow) damage that occurs to the tissues or organs supplied by the clamped artery. Shorter cross clamp time may result in less ischemic damage compared to longer clamp times, which can be particularly important in surgeries that involve major blood vessels or organs with high metabolic demands, such as the heart or brain[5,6,7,8].

Lower risk of complications: Shorter cross clamp time may be associated with a lower risk of complications related to ischemic injury, such as tissue necrosis (cell death), organ dysfunction, or postoperative complications. For example, in cardiac surgery, shorter cross clamp time during coronary artery bypass graft (CABG) surgery has been associated with reduced risk of complications like myocardial injury and acute kidney injury[3,6,8].

Faster recovery: Shorter cross clamp time may allow for faster recovery and shorter hospital stays, as the reduced ischemic damage and lower risk of complications can result in better postoperative outcomes. Patients may experience less pain, have improved organ function, and regain their normal physiological state more quickly, leading to a faster recovery process[9,10]. Decreased risk of adverse events: Shorter cross clamp time may decrease the risk of adverse events associated with prolonged ischemia, such as arrhythmias, stroke, or other ischemic-related complications. This can be particularly relevant in surgeries involving critical organs like the brain or heart, where minimizing ischemic injury is crucial to reduce the risk of adverse events.Improved overall surgical outcomes: Shorter cross clamp time may contribute to improved overall surgical outcomes, including reduced morbidity and mortality rates. By minimizing the duration of ischemic injury, shorter cross clamp time may help optimize patient outcomes, especially in high-risk surgical procedures[4,5,8,10,11].

It's important to note that the appropriate duration of cross clamp time can vary depending on the type of surgery, patient characteristics, and other individual factors. Surgical decisions should always be made by qualified healthcare professionals based on the specific clinical situation and patient needs.Coronary artery disease (CAD) is a condition characterized by the buildup of plaque in the arteries that supply blood to the heart muscle. In cases where CAD requires surgical intervention, coronary artery bypass graft (CABG) surgery may be performed. During CABG surgery, the heart is temporarily stopped and blood flow is rerouted through a heart-lung machine, while the blocked arteries are bypassed using grafts from other blood vessels[8,10,12,13].

Cross clamp time refers to the duration during which the aorta, the main artery that carries blood from the heart to the rest of the body, is clamped shut during CABG surgery. Longer cross clamp time can have an impact on cardiac enzyme levels in patients undergoing CABG surgery. Cardiac enzyme levels are markers of myocardial injury and their elevation can indicate damage to the heart muscle.Prolonged cross clamp time during CABG surgery may increase the risk of myocardial injury, which can result in higher cardiac enzyme levels. Several factors can contribute to myocardial injury during longer cross clamp time, including ischemic injury to the heart muscle due to reduced blood

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flow during clamping, and reperfusion injury when the clamp is released and blood flow is restored[14,15,16].

Elevated cardiac enzyme levels in patients undergoing CABG surgery may be associated with increased risks of adverse outcomes, such as postoperative complications, longer hospital stays, and higher mortality rates. Therefore, minimizing cross clamp time during CABG surgery is generally considered beneficial to reduce the risk of myocardial injury and associated complications. It is important to note that the appropriate cross clamp time during CABG surgery may vary depending on various factors, including the patient's overall health, the complexity of the surgery, and the surgeon's expertise. The decision on cross clamp time should always be made by a qualified healthcare professional, taking into consideration the individual patient's needs and the specific clinical situation.[17,18]Aortic cross clamp time > 90 min was shown to be associated with more need of inotropic drugs in a study. We aimed to identify statistical difference in cardiac enzyme levels in patients undergoing CABG between longer and shorter cross clamp time in our population to establish local data

MATERIAL AND METHODS

This randomized control trial was conducted in the Department of Cardiovascular Surgery, Punjab Institute of Cardiology Lahore from 2nd April 2020 to 2nd October 2020 (6 months) after IRB permission. Population of this study was cardiac patients of PIC Lahore. Sample Size was 300 (n1 150, n2 150) using 5% level of significance and 80% power of test. Sampling technique used was non–probability, consecutive sampling.

Inclusion criteria:

1. Patients with age range 20-70 years.
2. Patients with both Genders.
3. Patients undergoing on pump CABG with aortic cross clamp time 40-120 minutes.

Exclusion criteria:

1. Existence of preop medically treated renal disease creatinine > 1.5
2. Acute myocardial infarction with emergent surgery
3. Re-operations for CABG, concomitant valve and/or vascular surgery
4. Off-pump CABG operations
5. Left ventricle ejection fraction equal or worse than 35%

Data Collection Procedure: A total of 300 cases undergoing elective coronary artery disease were enrolled in the study. Patients were divided into two groups 150 were included in shorter cross clamp group ≥60minutes. Written informed consent was obtained from all the patients. The data of the patients was collected in a well-designed proforma. Demographic, clinical characteristics and outcomes were recorded. All operations were done in same institute. On pump CABG was performed during moderate hypothermic cardiopulmonary bypass. CPB was instituted after achieving full anticoagulation using heparin at a dose of 300 IU/kg .CPB flow rates were maintained at 2.4 l/min m2 with perfusion pressure kept around 70- 80 mmHg. Hematocrit was kept above 21% and temperature was drift down to 32°C during CPB. Blood based cardioplegia was used. During period of aortic clamp, distal anastomosis was performed while proximal anastomosis was done using partial aortic clamping. The sternotomy wound was then closed in layers and patients were shifted to the Intensive Care Unit. Intra aortic balloon counterpulsation was used if required. Troponin I and CKMB measurements were recorded 2 times for each patient. Blood samples were taken before cross clamping and on postoperative 1st day for CK MB levels. Need for inotropic support, was recorded in the groups (as per operational definitions).

Statistical Analysis: Collected data was analyzed through SPSS (Statistical Package for Social Sciences) version 25. Continuous variables i.e., age, height, weight, EF, CPB time, aortic cross clamp time Troponin I and CK MB were expressed as mean ± SD. Categorical variables i.e., gender, risk factors and postoperative complication were expressed as frequencies and percentages. Chi square test was used to compare the need of inotropes between both groups, and t-test was used to compare mean cardiac enzymes levels. Data was stratified for age, gender, HTN (BP160/90), DM (BSR-200 mg/dl) and dyslipidemia. P value ≤0.05 was considered statistically significant.

Operational Definitions:

Cardiac enzyme: Was defined as creatine kinase MB (CKMB) accessed preoperatively and on first post-operative day measured in IU/L.

Aortic cross clamp time: It was labelled as short if duration of aortic cross clamp clamp<60minutes and was labelled as long if duration of aortic cross clamp ≥60minutes.

RESULTS

Table-1: Comparison of CPB time in both groups

	CPB Time (Mean±S.D)	P-Value
Group A	93.72±29.97	0.001
Group B	121.04±31.83	

Table 1 showed that the mean CPB time in Group A was 93.72 ± 29.97 and mean CPB time in Group B was 121.04 ± 31.83. The P-Value was 0.001 which is highly significant showing that there is a significant difference in CPB time given to both groups.

Table-2: Comparison of Cross Clamp time in both groups.

	Cross Clamp Time (Mean±S.D)	P-Value
Group A	47.02 ± 7.07	< 0.001
Group B	73.42±17.31	

Table 2 showed that the mean Aortic Cross Clamp time in Group A was 47.02±7.07 and mean Aortic Cross Clamp time in Group B was 73.42±17.31. The P-Value was <0.001 which is highly significant showing that there is a significant difference in Aortic Cross Clamp time given to both groups.

Table-3: Comparison of CKMB Levels in both groups.

	Pre CKMB (IU/L) Mean ± S.D	Post CKMB (IU/L) Mean ± S.D	P-Value
Group A	44.94 ± 47.87	26.89 ± 22.47	<0.001
Group B	56.78 ± 102.17	38.51 ± 25.10	

Table-4: Comparison of Troponin I Levels in both groups.

	Pre Trop I (ng/ml) Mean ± S.D	Post Trop I (ng/ml) Mean ± S.D	P-Value
Group A	1.24 ± 3.98	0.29 ± 1.32	0.007
Group B	1.80 ± 5.86	1.05 ± 5.05	

Table 3 and 4 showed the comparison of CKMB and Troponin I levels in both groups. P-values of both groups are significant 0.001 and 0.007 respectively showing significant improvement in enzymes levels post operatively in both groups. It demonstrates that shorter cross clamp time improve the post-operative outcomes of patients.

Table 5: Descriptive statistic of age (years)

Age Groups	Frequency	Percentage
20-30	0	0
31-40	6	2.0
41-50	73	24.3
51-60	111	37.0
61-70	110	36.7
Total	300	100.0
Mean ± S.D	56.77 ± 8.03	
Mean ± S.D (Group A)	56.64 ± 7.53	
Mean ± S.D (Group B)	56.89 ± 8.52	
Minimum-Max	37-70	

Fig-1: Gender distribution of patients.

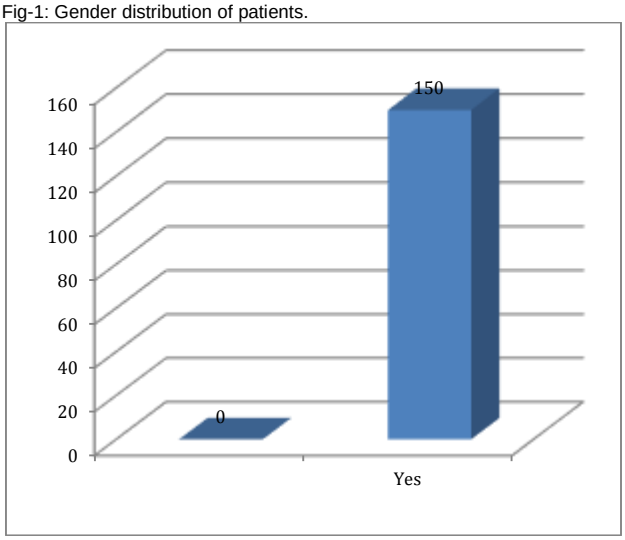
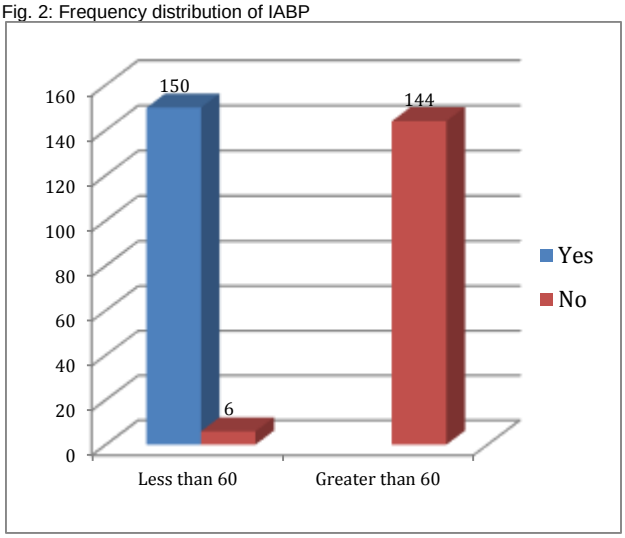


Table-5-A: Descriptive Statistic of height, weight and Pre-op Ejection Fraction.

	Height (cm)	Weight (kg)	EF
Mean	167.06	74.09	52.17
S. D	9.97	12.59	8.98
Range	77	76	47
Minimum	120	44	23.00
Maximum	197	120	70.00

Fig. 2: Frequency distribution of IABP



DISCUSSION

Longer cross clamp time leads to myocardial damage with release of myocardial enzymes leading to adverse events in perioperative period. So we conducted this study to compare mean cardiac enzyme levels in longer cross clamp time vs. shorter cross clamp time in patients undergoing CABG in our local population. Total 300 patients got enrollment for study and were divided in 2 equal groups. 150(50%) patients were designated group A (shorter cross clamp time and 150(50%) patients were designated in group B (longer cross clamp time). Out of these 300, 246 patients (82%) were males and 54(18%) were females[8,12,19,20].

Longer cross clamp time during cardiac surgeries, such as coronary artery bypass graft (CABG) surgery, can potentially lead to myocardial damage. The cross clamp is used to temporarily stop blood flow through the aorta, the main artery that carries blood from the heart to the rest of the body, during certain cardiac procedures. Prolonged cross clamp time can result in reduced blood flow to the heart muscle, leading to ischemic injury and potential damage to the myocardium, which is the muscle tissue of the heart[21,22,23,24]. During the period of cross clamp time, the heart is deprived of oxygen and nutrients, and waste products build up in the cardiac tissue. This can result in myocardial damage, including cell death, inflammation, and impaired cardiac function. Reperfusion injury, which occurs when the clamp is released and blood flow is restored, can also contribute to myocardial damage due to the sudden reintroduction of oxygen and other substances to the previously deprived tissue, potentially causing oxidative stress and inflammation[9,13,15,24].

Myocardial damage resulting from longer cross clamp time can manifest as elevated levels of cardiac enzymes, such as troponin, creatine kinase (CK), and lactate dehydrogenase (LDH), in blood tests. These markers are commonly used to assess myocardial injury and can indicate the extent of damage to the heart muscle[18,25,26].

Minimizing cross clamp time during cardiac surgeries is generally considered important to reduce the risk of myocardial damage and its associated complications, including postoperative complications, longer hospital stays, and increased morbidity and mortality rates[27,28]. However, the appropriate cross clamp time may vary depending on the specific clinical situation, patient characteristics, and surgeon's judgment. It is always important to rely on the expertise of qualified healthcare professionals in determining the optimal cross clamp time during cardiac surgeries[29].

In our study the mean CPB time in Group A turned out to be 93.72±29.97 and mean CPB time in Group B turned out to be 121.04±31.83. The P-Value was 0.001 which is highly significant representing the difference in CPB time in both groups .Similar to this, in a previous study, the mean CPB times for the shorter and longer cross clamp groups, respectively, were 87.8221.45 and 134.1834.07, respectively, with a significant p-value of 0.001[30].

The mean Aortic Cross Clamp time in Group A was calculated as 47.02±7.07 and mean Aortic Cross Clamp time in Group B was calculated as 73.42±17.31. The P-Value turned out to be <0.001 which is highly significant to show difference in aortic Cross Clamp time in both groups. Only 6(2%) patients of Group B required insertion of IABP while no patient of Group A required IABP in this data which demonstrates less morbidity in shorter clamp groups. Likely another literature review showed significant P-value (0.014) of IABP in shorter and longer cross clamp group[31].

Significant improvement in enzymes levels post operatively in both groups was noted as evident by the comparison of significant P-values i.e., 0.001 and 0.007 of CKMB and Troponin I levels in both groups respectively. It clearly indicates that shorter cross clamp time is associated with improved post-operative outcomes of patients[12,18,30].Troponin I measurements were significantly higher with longer cross clamping time especially in clamp time of > 50 min[15,18].

The aortic cross clamp time and Troponin I levels are both important factors in assessing cardiac health and outcomes in patients undergoing cardiac surgery, particularly coronary artery bypass grafting (CABG) procedures.Aortic cross clamp time refers to the duration during which the aorta, the main artery that carries oxygenated blood from the heart to the rest of the body, is clamped shut during cardiac surgery. This is done to temporarily stop blood flow to the heart so that the surgeon can perform the necessary repairs or grafts. Prolonged aortic cross clamp time is associated with increased risk of myocardial injury, which can lead to poor outcomes, such as myocardial infarction (heart attack) or postoperative complications[5,8,13,18].

Troponin I is a protein released into the bloodstream when there is damage to the heart muscle. It is a sensitive and specific marker for myocardial injury, and elevated levels of Troponin I in

the blood are indicative of cardiac damage. Troponin I levels are commonly used as a diagnostic tool to detect myocardial infarction or other cardiac injuries.The relationship between aortic cross clamp time and Troponin I levels is complex, as prolonged aortic cross clamp time can lead to ischemia (lack of blood flow) and reperfusion injury (injury that occurs when blood flow is restored after a period of ischemia), both of which can cause myocardial injury and increase Troponin I levels. [18,19]Studies have shown that longer aortic cross clamp times are associated with higher postoperative Troponin I levels, indicating a greater degree of myocardial injury. However, the exact relationship may vary depending on various factors, such as patient characteristics, surgical techniques, and overall cardiac health[13,22,28].

In general, minimizing aortic cross clamp time is a goal during cardiac surgery, as it is associated with better outcomes. Close monitoring of Troponin I levels can provide valuable information about the extent of myocardial injury and help guide postoperative care. It is important to discuss any concerns or questions regarding aortic cross clamp time and Troponin I levels with a qualified healthcare professional, as they can provide personalized and comprehensive medical advice[32,33].

CONCLUSION

Longer cross clamp group showed greater Troponin I and CKMB readings as well as an increased need for IABP insertion. Longer CPB times are subsequently experienced by patients, and longer CPB times are directly correlated with increased mortality and morbidity. Longer aortic cross clamp time is therefore determined to be an independent predictor of morbidity in our group.

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