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Impact of Aortic Cross-Clamp Duration on Early Post-Operative Outcomes Following Coronary Artery Bypass Grafting: A Cross-Sectional Study

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Abstract

Objective: To evaluate the association between aortic cross-clamp duration and early post-operative outcomes in patients undergoing coronary artery bypass grafting (CABG).

Methodology: This cross-sectional study was conducted in Department of Cardiac Surgery Punjab Institute of Cardiology, Lahore, Pakistan, over a period of 6 months after obtaining ethical approval from the Institutional Review Board. A total of 190 patients aged 50–75 years who were admitted for elective CABG were included and classified into two cohorts according to aortic cross-clamp duration: low-risk (<75 minutes) and high-risk (≥75 minutes). Baseline demographic and clinical characteristics were measured. Patients were followed during the same hospital admission for early post-operative outcomes, including intensive care unit (ICU) stay, hospital stay, stroke and in-hospital mortality. Continuous variables were compared using the independent-samples t-test, while Fisher's exact test was used for categorical outcomes. A p-value ≤0.05 was considered statistically significant.

Results: Baseline demographic and clinical characteristics showed no statistically significant differences between the two groups. ICU stay and hospital stay were also comparable between groups. However, stroke occurred more frequently in the high-risk cohort than in the low-risk cohort (7.4% vs. 1.1%; p=0.030). In-hospital mortality was not significantly different between the high-risk and low-risk cohorts (8.4% vs. 5.3%; p=0.572).

Conclusion: Longer aortic cross-clamp duration was associated with a higher frequency of stroke among patients undergoing CABG, while early mortality, ICU stay and hospital stay remained comparable between the two cohorts. Careful perioperative monitoring and appropriate management of cross-clamp duration may help improve early post-operative outcomes.

Keywords: coronary artery bypass grafting, risk stratification, elderly patients, stroke, post operative outcomes

Introduction

Coronary artery disease (CAD) is one of the most leading causes of morbidity and mortality worldwide and represents a major public health issue, particularly in low socioeconomic countries.[1] The risk factors for increase prevalence of cardiovascular diseases are hypertension, diabetes mellitus, obesity and sedentary lifestyles etc. Consequently the number of patients are growing and requiring surgical revascularization procedures i.e. coronary artery bypass grafting (CABG).[2] It was introduced by René Favaloro, MD in 1960s. It is continues to be a well-established treatment option for patients with multivessel coronary artery disease to improve symptoms and survival rate.[3] With increasing life expectancy and better healthcare access, more older patients are having CABG, which makes evaluating their risks and early recovery important. During CABG surgery, temporary occlusion of the ascending aorta is done by using an aortic cross-clamp. It is commonly performed to provide a clear and controlled surgical field while protecting the myocardium with cardioplegia.[4] The use of cross-clamping evolved with the development of cardiopulmonary bypass techniques in the mid of 20th century and became a standard part of on-pump cardiac surgery. Although essential for safe grafting procedures, the duration of cross-clamp time is clinically important because prolonged myocardial ischemia may influence neurological complications and early post-operative recovery. Therefore, evaluating outcomes in relation to cross-clamp exposure has gained increasing attention in contemporary cardiac surgery research.[5]

Recent global data showed that ischemic heart disease affects millions of individuals worldwide and responsible for a significant proportion of cardiovascular mortality each year. Epidemiological studies have shown that South Asian populations have a higher risk of developing atherosclerotic cardiovascular disease compared with many other regions.[6] In Pakistan, CAD has emerged as a significant public health concern. According to local studies the prevalence of CAD is ranging from approximately one-quarter to over one-third of the adult population in certain urban areas. Rapid urbanization, smoking, metabolic disorders and limited awareness of preventive healthcare have contributed to this rising burden.[7]

Since long several clinical scoring systems and physiological indicators have been used to estimate surgical risk in patients undergoing cardiac procedures.[8] Variables such as age, body mass index (BMI) and left ventricular function are commonly incorporated into risk assessment models because they reflect overall health status and cardiovascular reserve. Similarly, anthropometric indicators such as BMI may influence post-operative complications through their association with metabolic health and inflammatory status.[9] Prolonged ICU admission not only reflects increased clinical complexity but a question mark on healthcare resources, especially in developing countries where critical care facilities may be limited.[10] Neurological events, including stroke, remain among the most concerning complications following cardiac surgery because of their impact on functional independence, long term disability and overall healthcare costs.[11] Early death after surgery depends on conditions of patients, treatment during surgery and hospital care. Understanding how baseline risk profiles relate to these outcomes is therefore essential to improve clinical decision making and guiding preventive strategies at both individual and population levels.

In many developing countries, including Pakistan, there is limited locally generated evidence showing risk stratification and early outcomes among elderly CABG patients. Most available studies focus primarily on surgical techniques or biochemical markers, while fewer investigations address demographic and epidemiological determinants of recovery.[12] As patient populations, healthcare resources and disease patterns vary between regions. Locally generated data are important for guiding clinical practice and policy decisions. So, the purpose of this study was to evaluate the impact of aortic cross-clamp duration on early post-operative outcomes in patients undergoing coronary artery bypass grafting (CABG).

Methodology

This cross-sectional study was conducted at the Department of Cardiac Surgery Punjab Institute of Cardiology, Lahore, Pakistan over a period of 6 months from November 2022-April 2023 after obtaining ethical approval from the Institutional Review Board No: UHS/Education/126-22/5722. Inclusion criteria was patients aged 50–75 years who were admitted in the hospital for an elective CABG surgery and both male and female patients. Exclusion criteria included patients with acute or recent myocardial infarction, emergency surgical cases, patients younger than 50 years or older than 75 years and patients with chronic renal disease or chronic obstructive pulmonary disease. A total of 190 eligible patients who were planned for an elective CABG were included during the study period. Patients fulfilling the predefined inclusion criteria were enrolled via non-probability convenient sampling technique and followed. Following surgery, patients were classified into two groups(n=95) according to the aortic cross-clamp duration recorded during the operation. Patients with a cross-clamp duration of <75 minutes were considered the low-risk group (Group A), whereas those with a duration of ≥75 minutes were considered the high-risk group (Group B). Aortic cross-clamp duration was considered the primary exposure variable.

Baseline demographic and clinical characteristics, including age, height, weight, body mass index (BMI) and ejection fraction (EF) were recorded before surgery. Patients were then followed during the same hospital admission to assess early post-operative outcomes

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e.g., duration of intensive care unit (ICU) stay, length of hospital stay, stroke (based on clinical assessment and documented neurological diagnosis in the patient's medical records) and in-hospital mortality (death occurring during the same hospital admission).

Statistical Analysis

Data was analyzed using SPSS version 25. Quantitative variables were expressed as mean ± standard deviation (SD) and categorical variables were presented as frequencies and percentages. Independent-samples t-test was used to compare continuous variables between the groups. Fisher's exact test was used to compare categorical outcomes e.g., stroke and in-hospital mortality. A p-value ≤0.05 was considered statistically significant.

Results

A total of 190 patients undergoing elective coronary artery bypass grafting (CABG) were included in the study. Based on the recorded aortic cross-clamp duration, 95 patients were classified into the low-risk group (<75 minutes; Group A) and 95 patients into the high-risk group (≥75 minutes; Group B).

Discussion

Our study evaluated the impact of aortic cross-clamp duration on early post-operative outcomes among patients undergoing coronary artery bypass grafting (CABG). Results of baseline characteristics e.g., age, height, weight, BMI and ejection fraction are shown in Table 1. Comparative analysis showed non-significant differences (p > 0.05) between the two groups, indicating similar preoperative risk profiles. Including participants with similar baseline characteristics helped to remove these major confounding factors and increased the validity of the results.

Similar results have been reported in other observational studies by Zhang et al., who compared CABG outcomes among patient groups with different baseline characteristics and evaluated their association with in-hospital outcomes and adverse events.[13]

In this study, measures of healthcare use, such as ICU stay and hospital stay did not differ significantly between groups (Table 2). These findings suggest that differences in cross-clamp duration were not associated with a significant increase in early healthcare utilization in the present cohort. Study of Jain et al. has also shown that improvements in anesthesia techniques, post-operative monitoring and early mobilization strategies have contributed to accelerate the durations of recovery, despite increasing surgical complexity.[14] Similarly, Hijazi reported comparable perioperative outcomes among CABG patients managed within an optimized perioperative care setting.[15]

Despite similar healthcare utilization outcomes, a higher frequency of stroke was observed among patients with longer cross-clamp duration (Table 3A). Neurological complications remain one of the most serious concerns after cardiac surgery because they are associated with long-term disability, reduced quality of life and increased healthcare burden.[16] Previous literature from the study of Shu et al. has highlighted that elderly patients are particularly vulnerable to perioperative neurological events due to age-related vascular changes and preexisting atherosclerosis.[17] A study by Islam et al. conducted in cardiac centers of Lady Reading Hos-

Table 1. Baseline Demographic and Clinical Characteristics of the Study Groups

Variable	Group A(n=95) Mean ± SD	Group B(n=95) Mean ± SD	p-value
Age (years)	59.82 ± 6.73	57.45 ± 6.36	0.321
Height (cm)	166.8 ± 7.66	166.3 ± 10.78	0.720
Weight (kg)	73.06 ± 11.30	73.52 ± 12.55	0.790
BMI (kg/m^2)	26.28 ± 3.85	28.20 ± 14.91	0.230
Ejection Fraction (%)	48.84 ± 10.53	46.74 ± 10.36	0.166

Independent-samples t-test was used.

Table 2. Early Post-Operative Outcomes and Healthcare Utilization

Variable	Group A(n=95) Mean ± SD	Group B(n=95) Mean ± SD	p-value
ICU Stay (days)	4.78 ± 3.26	5.36 ± 3.49	0.239
Hospital Stay (days)	12.54 ± 7.37	12.53 ± 6.26	0.992

Independent-samples t-test was used.

Table 3. Comparison of Early Morbidity and In-hospital Mortality

3A — Stroke			
Stroke	**Group A (n=95) (%)**	**Group B (n=95) (%)**	**p-value**
Yes	1 (1.1%)	7 (7.4%)	0.030
No	94 (98.9%)	88 (92.6%)	
Total	95 (100%)	95 (100%)	
3B — Mortality	**Group A (n=95) (%)**	**Group B (n=95) (%)**	**p-value**
Yes	5 (5.3%)	8 (8.4%)	0.572
No	90 (94.7%)	87 (91.6%)	
Total	95 (100%)	95 (100%)	

Fisher's exact test was used for categorical comparisons.

pital, KPK, Pakistan have reported that postoperative stroke rates ranging from 2- 5%, with higher incidence observed in patients exposed to longer operative durations or greater perioperative along with older age.[18] These findings align with the results of the present study and emphasize the importance of careful neurological monitoring and preventive strategies in elderly populations undergoing CABG. A possible mechanism linking prolonged cross-clamp duration with increased stroke risk is the longer exposure to cardiopulmonary bypass and myocardial ischemia, which may contribute to cerebral hypoperfusion and inflammatory or embolic events. Patients with underlying vascular disease may be particularly susceptible to these neurological effects during prolonged cardiac surgery.

The absence of a statistically significant difference in in-hospital mortality between groups is another important finding (Table 3B). Early mortality after CABG is known to be influenced by multiple factors, including patient comorbidities, perioperative management and institutional expertise.[19] Many studies have shown that while surgical factors may affect complication rates, their direct effect on early mortality has reduced over time because of better surgical techniques and improved postoperative care.[20,21] This may partly explain the comparable mortality observed between the groups in the present study. From a public health perspective, these findings highlight the importance of maintaining effective perioperative care and continuous quality improvement in cardiac surgical services.[22]

Perioperative assessment remains an important part of surgical planning and management of healthcare resources, particularly in patients undergoing CABG who may require closer monitoring because of their clinical and physiological characteristics. Age, body mass index and ejection fraction are widely recognized indicators of baseline health status and have been incorporated into several predictive models used in cardiac surgery. Although these variables were similar between groups in the current study, their inclusion in risk assessment frameworks remains important to identify the high risk individuals and to guide in clinical decision making.[23] In developing countries, including Pakistan, locally generated evidence on CABG outcomes remains important for improving patient care and resource planning. The present study provides local data regarding the relationship between cross-clamp duration and early post-operative outcomes. These findings may assist clinicians in identifying patients who require closer neurological monitoring and appropriate perioperative management. As the number of older patients undergoing CABG increases, continued evaluation of modifiable perioperative factors may help improve surgical safety and patient outcomes.

This study was conducted at a single center with a relatively limited sample size, which may reduce the generalizability of the results to other populations. The analysis focused on early post-operative outcomes only and did not include long-term follow up. In addition, potential confounding factors such as diabetes mellitus, hypertension, extent of coronary artery disease, number of grafts, cardiopulmonary bypass (CPB) time and surgeon variability were not adjusted for in the analysis. Therefore, their possible influence on the observed outcomes cannot be excluded. Future multicenter studies with larger sample sizes and longer follow up periods are recommended to further evaluate the relationship between aortic cross-clamp duration and post-operative outcomes in patients undergoing CABG.

Conclusion

In this study, patients undergoing CABG with longer aortic cross-clamp duration showed a higher frequency of stroke, while early mortality and healthcare use measures such as ICU stay and hospital stay remained comparable between groups. Baseline demographic

and clinical characteristics were generally similar between the two cohorts. These findings highlight the importance of careful perioperative monitoring and appropriate management of aortic cross-clamp duration to improve early post-operative outcomes in patients undergoing cardiac surgery.

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Authors' Contribution Statement

MSHA contributed to the conception, design, acquisition, analysis, interpretation of data, drafting of the manuscript, critical review of the manuscript, and final approval of the version to be published. NEI contributed to the acquisition, analysis, interpretation of data, and drafting of the manuscript. MFA contributed to the acquisition, analysis, interpretation of data, and drafting of the manuscript. SSI contributed to the acquisition, analysis, interpretation of data, and drafting of the manuscript. TMB contributed to the acquisition, analysis, interpretation of data, and drafting of the manuscript. SF contributed to the acquisition, analysis, interpretation of data, and drafting of the manuscript. All authors are accountable for their work and ensure the accuracy and integrity of the study.

Conflict of Interest

Authors declared no conflict of interest

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None

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.