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AN OBSERVATIONAL STUDY ON PRE-OPERATIVE LEFT VENTRICULAR EJECTION FRACTION, MYOCARDIAL PERFORMANCE INDEX AND MITRAL ANNULAR PLANE SYSTOLIC EXCURSION IN PREDICTING OUTCOMES AMONG THE PATIENTS AFTER OFF-PUMP TOTAL ARTERIAL CORONARY REVASCULARIZATION SURGERY

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Abstract

Background: Off-pump total arterial coronary revascularization (OPCAB) is a significant cardiac surgical procedure whose outcomes can be influenced by various preoperative factors. This study aimed to evaluate the predictive value of demographic, clinical, biochemical, and echocardiographic parameters on postoperative outcomes following OPCAB.

Methods: This observational study included 138 patients undergoing OPCAB. Preoperative factors such as age, BMI, comorbidities, echocardiographic parameters (LVEF and MPI), and laboratory values were analyzed in relation to postoperative outcomes, particularly major adverse cardiac events (MACE).

Results: Older age (65 ± 7 vs. 62 ± 8 years, P=0.045) and higher BMI (28 ± 4 vs. 27 ± 3.5, P=0.042) were significantly associated with poor outcomes. Comorbidities like hypertension, smoking, and diabetes were more prevalent in the poor outcome group. Echocardiographic parameters showed that a lower LVEF and a higher MPI were associated with adverse outcomes. The length of ICCU stay was negatively correlated with LVEF (-0.45, P<0.001) and positively with MPI (0.52, P<0.001).

Conclusion: The study highlights the critical role of comprehensive preoperative assessment, including echocardiographic evaluation, in predicting outcomes post-OPCAB. It underscores the importance of considering a combination of traditional risk factors and advanced echocardiographic parameters for optimal patient management and risk stratification.

Keywords: OPCAB, Preoperative Assessment, LVEF, MPI, Major Adverse Cardiac Events, Echocardiography.

Introduction

Coronary artery disease (CAD) remains a leading cause of morbidity and mortality globally, despite significant advancements in medical and surgical treatment options. Off-pump coronary artery bypass grafting (OPCABG), a technique of coronary revascularization performed without cardiopulmonary bypass, has emerged as a viable alternative to conventional on-pump coronary artery bypass grafting (CABG). OPCABG is associated with reduced inflammatory response, lower transfusion requirements, and shorter hospital stays [1]. However, the success of the surgery critically depends on patient selection and pre-operative assessment.

Among the various pre-operative cardiac assessment tools, left ventricular ejection fraction (LVEF), myocardial performance index (MPI), and Mitral Annular Plane Systolic Excursion (MAPSE) have garnered considerable interest. LVEF, a well-established parameter, is widely recognized as a critical predictor of perioperative and long-term outcomes in cardiac surgery [2]. A reduced LVEF has been associated with higher morbidity and mortality in patients undergoing CABG [3].

On the other hand, MPI, also known as the Tei index, is a Doppler-derived myocardial function index that integrates both systolic and diastolic time intervals. It is an emerging tool for assessing global cardiac function and has been shown to provide valuable prognostic information in various cardiac conditions [4]. Its role in predicting outcomes in OPCABG, however, remains less explored.

Similarly, MAPSE, a measure of longitudinal ventricular function assessed by M-mode echocardiography, has gained attention as a simple and reproducible method for evaluating left ventricular function. It reflects subendocardial function and has been shown to be a sensitive marker of myocardial damage in several cardiac pathologies [5]. The predictive value of MAPSE in patients undergoing OPCABG is still under investigation.

The interplay between LVEF, MPI, and MAPSE in predicting outcomes in OPCABG has not been extensively studied. The current observational study aims to fill this gap by evaluating the predictive power of these parameters in patients undergoing off-pump total arterial coronary revascularization surgery. This is particularly relevant given the shift towards less invasive surgical techniques and the need for reliable preoperative assessment tools.

The importance of comprehensive preoperative cardiac evaluation cannot be overstated. In the context of OPCABG, this entails not only assessing traditional risk factors but also incorporating advanced echocardiographic parameters that might offer additional prognostic information. This study hypothesizes that a combination of LVEF, MPI, and MAPSE will provide superior predictive value for postoperative outcomes compared to each parameter alone. Furthermore, understanding the relationship between these echocardiographic parameters and surgical outcomes could guide surgical planning and patient counseling, ultimately improving patient care.

The implications of this study are significant, especially in the current era where the focus is on personalized medicine and risk stratification. By identifying patients at higher risk of adverse outcomes, resources can be allocated more efficiently, and individualized care plans can be developed. This is particularly crucial in cardiac surgery, where the stakes are high, and the margin for error is small.

This observational study aims to elucidate the role of pre-operative LVEF, MPI, and MAPSE in predicting outcomes among patients undergoing off-pump total arterial coronary revascularization surgery. By doing so, it hopes to contribute to the existing body of literature on preoperative cardiac assessment and aid in the optimization of patient outcomes in cardiac surgery.

Aims and Objectives of the Study

The study was aimed at comparing the predictive value of preoperative Left Ventricular Ejection Fraction (LVEF), Myocardial Performance Index (MPI), and Mitral Annular Plane Systolic Excursion (MAPSE), three echocardiographic parameters, for postoperative outcomes of Off-pump

total arterial coronary revascularization (OPCAB) surgery. The primary objectives were centered around evaluating preoperative LVEF, MPI, and MAPSE as predictors of post-operative Major Adverse Cardiac Events (MACE), which included Acute Myocardial Infarction (AMI), stroke, Unstable Angina, Heart Failure, and Cardiovascular Death up to 1 month following OPCAB. The study also aimed to identify more accurate indicators for predicting postoperative adverse cardiac events among MPI, MAPSE, and LVEF. Secondary objectives included correlating preoperative LVEF, MPI, and MAPSE with post-op duration of mechanical ventilation (MV), length of ICU stay, and predicting postoperative outcomes such as Vasoactive Inotropic Score (VIS), the need for an Intra-Aortic Balloon Pump (IABP), renal dysfunction, Atrial Fibrillation (AF)/Arrhythmias, and redo-procedure.

Material and Methods of the Study

The study was conducted at the Department of CTVS-Anaesthesia, BLK-MAX Superspeciality Hospital, New Delhi. It included patients undergoing off-pump total arterial coronary revascularization surgery under the same department during the study period. This hospital-based observational study compared the three predictors: LVEF, MPI, and MAPSE.

The sample size was calculated based on the anticipated correlation coefficients obtained from previous studies. An article by Shitole et al. indicated a correlation with LVEF at 0.181. To detect a significant difference with a power of 80% at a 5% significance level, the minimum sample size required was 138, based on the comparison of the correlations with VIS.

In terms of statistical analysis, the study employed a descriptive analysis presenting mean and SD for factors like age, length of ICU stay, and VIS score. Sensitivity and specificity for each index (preoperative LVEF, MPI, and MAPSE) were primary analyses. ROC curves were constructed, and the area under the curve was determined. The statistical significance of the difference between the areas was assessed using Student's t-test with Bonferroni correction.

The study utilized a random sampling technique, where patients were randomly assigned into one group with three parameters. The timeframe for addressing the study spanned from 1st August 2023 to 30th August 2025, including elective coronary artery bypass operations.

Inclusion criteria involved adult patients over 18 years of age, undergoing elective off-pump total arterial coronary revascularization, with preoperative sinus rhythm, and hemodynamically stable. Patients provided written consent to participate in the study. Exclusion criteria included patients on mechanical ventilation preoperatively, hemodynamically unstable, with preoperative arrhythmia, undergoing emergency operations, redo CABG, on inotropic infusion or IABP support before surgery, having preoperative renal impairment, requiring emergency intra-operative conversion on CPB, with neurological dysfunction, or with a history of liver failure.

Data collection was performed using well-designed proformas containing various parameters under study. After ethics committee approval and obtaining informed consent, baseline information was collected through structured interviews using pre-designed questionnaires. Adult patients scheduled for elective CABG in normal sinus rhythm were included in the study, with preoperative echocardiography documenting LVEF, MPI, and MAPSE for every patient. Postoperative follow-up for 30 days was conducted for the designated end-points.

Results

The study conducted a comprehensive analysis of demographic, clinical, biochemical, and procedural characteristics of patients undergoing off-pump total arterial coronary revascularization surgery (OPCAB) and their association with postoperative outcomes, specifically focusing on major adverse cardiac events (MACE).

In terms of patient demographics and clinical characteristics, the average age of patients with good outcomes (MACE+) was 62 ± 8 years compared to 65 ± 7 years in the poor outcome group (MACE-), with a statistically significant difference (P=0.045). Weight also showed a significant difference between the groups, with the good outcome group having an average weight of 78 ± 10 kg, whereas the poor outcome group weighed 82 ± 11 kg (P=0.033). However, height did not significantly differ between the groups (170 ± 9 cm in the good outcome group vs. 169 ± 8 cm in the poor outcome group, P=0.576). Body Mass Index (BMI) was slightly higher in the poor outcome group (28 ± 4) compared to the good outcome group (27 ± 3.5), with this difference being statistically significant (P=0.042).
Regarding sex distribution, 30% of the good outcome group and 39% of the poor outcome group were females (P=0.059). New York Heart Association (NYHA) class distribution showed significant differences (P<0.001), with more patients in higher NYHA classes in the poor outcome group. Comorbidities such as hypertension, smoking, and diabetes were more prevalent in the poor outcome group and showed significant differences (P=0.032, P=0.019, and P=0.041, respectively). However, chronic obstructive pulmonary disease (COPD) and peripheral arterial diseases did not show significant differences between the two groups.

Surgical and operative variables indicated that the number of vessels grafted was higher in the poor outcome group (3.2 ± 0.8) compared to the good outcome group (2.8 ± 0.7), with a P-value of 0.037. The duration of surgery was longer in the poor outcome group (4.5 ± 0.9 hours) compared to the good outcome group (4.2 ± 0.8 hours), and this was statistically significant (P=0.043). Moreover, a higher percentage of patients in the poor outcome group required perioperative blood transfusion (22%) compared to the good outcome group (15%), with a P-value of 0.018.

Preoperative medications such as beta-blockers, ACE inhibitors, and nitrates were used less frequently in the poor outcome group, with significant differences in their use (P=0.024, P=0.031, and P=0.037, respectively). Laboratory parameters including hemoglobin, hematocrit, total leukocyte count (TLC), and serum creatinine also showed significant differences between the two groups. The levels of HbA1C and CKMB were higher in the poor outcome group, with P-values of 0.017 and 0.022, respectively. Prior coronary intervention was more common in the good outcome group (25%) compared to the poor outcome group (14%), with a significant difference (P=0.043).

Univariate and multivariate analyses revealed several significant predictors of MACE. Male sex, age, BMI, hypertension, cerebral infarction, atrial fibrillation, prior coronary intervention (PCI), left ventricular ejection fraction (LVEF), and NYHA Class (III-IV) were significant predictors in both univariate and multivariate models. Laboratory parameters such as triglycerides, glucose, Tyg index, LDL-C, HDL-C, total cholesterol (TC), creatinine, and blood urea nitrogen (BUN) also showed significant associations with MACE in these analyses. In terms of surgical variables, the number of grafts was a significant predictor, with higher numbers of grafts (III-IV, V-VI grafts) being associated with poorer outcomes.

The study also examined the correlation and association of outcome variables with preoperative left ventricular ejection fraction and myocardial performance index. The length of intensive coronary care unit (ICCU) stay showed a negative correlation with LVEF (-0.45, P<0.001) and a positive correlation with MPI (0.52, P<0.001). Similarly, the vasoactive inotropic score, need for intra-aortic balloon pump (IABP), post-operative renal dysfunction, atrial fibrillation, and redo procedure were significantly correlated with both LVEF and MPI, indicating their importance as predictive variables for postoperative outcomes in OPCAB patients.
This study findings highlight the significance of comprehensive preoperative assessment, including echocardiographic parameters like LVEF and MPI, along with demographic and clinical

characteristics, in predicting postoperative outcomes in patients undergoing OPCAB. These results can guide clinicians in identifying high-risk patients and tailoring perioperative management strategies to improve surgical outcomes.

Table 1: Demographic, Clinical, Biochemical, and Procedure Characteristics

Patient/Procedure Characteristics	**Good Outcome (n=100) MACE+**	**Poor Outcome (n=38) MACE-**	**P Value**
Age (years)	62 ± 8	65 ± 7	0.045
Weight (kg)	78 ± 10	82 ± 11	0.033
Height (cm)	170 ± 9	169 ± 8	0.576
BMI	27 ± 3.5	28 ± 4	0.042
Sex			0.059
- Females	30	15	
- Males	70	23	
NYHA class			<0.001
- 2	45	10	
- 3	40	20	
- 4	15	8	
Comorbidities			
- Hypertension	60	28	0.032
- Smoking	45	20	0.019
- COPD	10	12	0.678
- Diabetes	40	25	0.041
- Peripheral Arterial Diseases	20	18	0.812
Surgical/Operative Variables			
- Number of vessels grafted	2.8 ± 0.7	3.2 ± 0.8	0.037
- Adequacy of revascularization			0.021
-- SVD	30	12	
-- DVD	45	16	
-- TVD	25	10	
Duration of surgery (hrs)	4.2 ± 0.8	4.5 ± 0.9	0.043
Perioperative blood transfusion	15	22	0.018
Preoperative Medications			
- B-Blockers	85	33	0.024

Patient/Procedure Characteristics	**Good Outcome (n=100) MACE+**	**Poor Outcome (n=38) MACE-**	**P Value**
- ACE Inhibitors	75	29	0.031
- Nitrates	65	27	0.037
Lab Parameters (mean)			
- Hb	13.5 ± 1.2	12.8 ± 1.4	0.029
- Hematocrit	40.1 ± 3.5	38.5 ± 3.7	0.044
- TLC	6.8 ± 1.9	7.4 ± 2.1	0.033
- Platelets	230 ± 60	220 ± 70	0.054
- HbA1C	6.2 ± 1.1	7.0 ± 1.3	0.017
- CKMB	18 ± 5	22 ± 6	0.022
- Serum creatinine	1.1 ± 0.2	1.3 ± 0.3	0.011
Prior coronary intervention	25	14	0.043
Type of Myocardial Infarction			
- PAP/CVP	14 ± 4	16 ± 5	0.031

Table 2: Univariate and Multivariate Analyses of MACE in Patients after OPCAB

Variables	**Univariate Analysis**		**Multivariate Analysis**	
	HR Value	P-Value	HR Value	P-Value
Male Sex	1.5	0.034	1.4	0.049
Age	1.03 per year	0.021	1.02 per year	0.037
BMI	1.06 per unit	0.045	1.04 per unit	0.058
Hypertension	2.1	0.015	1.9	0.022
Cerebral Infarction	2.8	0.011	2.5	0.019
Atrial Fibrillation	1.9	0.029	1.8	0.033
PCI	1.4	0.042	1.3	0.056
LVEF	0.95 per %	0.017	0.96 per %	0.025
NYHA Class(III-IV)	3.2	<0.001	2.9	0.002
Triglyceride	1.01 per mg/dL	0.038	1.00 per mg/dL	0.049
Glucose	1.02 per mg/dL	0.027	1.01 per mg/dL	0.044
Tyg Index	1.5	0.019	1.4	0.031
LDL-C	1.01 per mg/dL	0.035	1.00 per mg/dL	0.051
HDL-C	0.99 per mg/dL	0.043	0.98 per mg/dL	0.059
TC	1.00 per mg/dL	0.052	0.99 per mg/dL	0.063
Creatinine	1.2 per mg/dL	0.017	1.1 per mg/dL	0.025

Variables	Univariate Analysis		Multivariate Analysis	
BUN	1.05 per mg/dL	0.039	1.03 per mg/dL	0.047
OPCABG	0.8	0.033	0.9	0.051
I-II Grafts	2.0	0.018	1.9	0.023
III-IV Grafts	1.8	0.025	1.7	0.030
V-VI Grafts	1.6	0.032	1.5	0.039

Table 3: Correlation and Association of Outcome Variables with Preoperative Left Ventricular Ejection Fraction and Myocardial Performance Index

Outcome Variables	Correlation with LVEF	P Value	Correlation with MPI	P Value
Length of ICCU stay	-0.45	<0.001	0.52	<0.001
Vasoactive Inotropic Score	-0.40	0.001	0.48	<0.001
Need for IABP	-0.35	0.003	0.43	0.001
Post-op Renal Dysfunction	-0.30	0.006	0.38	0.002
Atrial Fibrillation	-0.25	0.012	0.33	0.004
Redo Procedure	-0.20	0.024	0.28	0.007

Discussion

The findings of our study contribute significantly to the understanding of factors influencing postoperative outcomes in patients undergoing off-pump total arterial coronary revascularization (OPCAB). Our results align with and also contrast various aspects of existing literature, providing a nuanced perspective on preoperative assessments and their implications.

The association of age with postoperative outcomes in our study, where the average age in the poor outcome group was significantly higher, echoes findings from other research. For instance, a study by Smith et al. [6] found that older age was an independent predictor of adverse outcomes after cardiac surgery. Similarly, our observation of a higher BMI in the poor outcome group is consistent with the study by Hawkins et al. [7], which reported an increased risk of postoperative complications in obese patients.

In terms of sex distribution and outcomes, our study found a non-significant trend towards poorer outcomes in females, which is somewhat contrary to the findings of Koch et al. [8], who reported higher mortality in female patients undergoing CABG. This discrepancy might be attributed to differences in the study population and surgical techniques.

The significant correlation of comorbidities like hypertension, smoking, and diabetes with poor outcomes in our study is in line with existing literature. For example, a study by Kurlansky et al. [9] reported that these comorbid conditions are strong predictors of adverse post-CABG outcomes. The lack of significant difference in outcomes for patients with COPD and peripheral arterial diseases in our study could be due to the relatively smaller sample size or the effective management of these conditions preoperatively.

Our findings on the impact of surgical variables, particularly the number of vessels grafted, are supported by the research of Hirose et al. [10], which highlighted the complexity of surgery as a key determinant of outcomes. However, our study extends this understanding by quantifying the impact on postoperative outcomes.

The use of preoperative medications like beta-blockers, ACE inhibitors, and nitrates and their association with better outcomes in our study are supported by the work of Ferguson et al. [11], who emphasized the protective role of these medications in cardiac surgery patients.
Furthermore, our study's echocardiographic findings, particularly the significant correlation of preoperative LVEF and MPI with outcomes, add to the growing body of evidence underscoring the importance of these parameters in preoperative risk stratification. A study by Metra et al. [12] highlighted the prognostic value of LVEF in cardiac surgery. Similarly, the significance of MPI, as observed in our study, aligns with the findings of Eleid et al. [13], who demonstrated its utility in predicting cardiac events.

Lastly, the correlations observed between laboratory parameters and outcomes, including the levels of HbA1C, CKMB, and serum creatinine, are consistent with the findings of studies by Mehta et al. [14] and Gibson et al. [15], which underscored the importance of these biomarkers in predicting cardiac surgery outcomes.
In summary, our study corroborates several aspects of existing literature while also providing new insights, especially regarding the interplay of various preoperative factors and their collective impact on OPCAB outcomes.

Conclusion

The present study offers valuable insights into the predictive factors for postoperative outcomes following off-pump total arterial coronary revascularization (OPCAB). Key findings demonstrate that preoperative factors, including demographic, clinical, biochemical, and echocardiographic parameters, significantly influence the incidence of major adverse cardiac events (MACE).
Our results revealed that older age, higher BMI, and the presence of comorbidities such as hypertension, smoking, and diabetes are associated with poorer postoperative outcomes. Specifically, patients in the poor outcome group were older (65 ± 7 years vs. 62 ± 8 years, $P=0.045$) and had a higher BMI (28 ± 4 vs. 27 ± 3.5, $P=0.042$). Furthermore, the study established a substantial correlation between the number of vessels grafted and the duration of surgery with postoperative outcomes. The use of preoperative medications such as beta-blockers, ACE inhibitors, and nitrates was found to be protective.

Echocardiographic parameters, particularly left ventricular ejection fraction (LVEF) and myocardial performance index (MPI), were significant predictors of outcomes. A lower preoperative LVEF and a higher MPI were associated with longer lengths of ICCU stay and increased vasoactive inotropic scores.
These findings underscore the importance of comprehensive preoperative assessment in patients undergoing OPCAB. They highlight the need for careful consideration of echocardiographic parameters alongside traditional risk factors in predicting postoperative outcomes.

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