ORIGINAL RESEARCH

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Predictors of postoperative atrial fibrillation after off-pump coronary artery bypass grafting – a prospective observational study

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Abstract

Objective: Postoperative atrial fibrillation (AF) is a common and potentially morbid complication following coronary artery bypass graft (CABG) surgery. Many factors have been suggested to increase the incidence of postoperative AF after CABG. The objective was to estimate the proportion of patients developing AF after off-pump CABG (OPCABG) and to determine the possible predictors of AF after OPCABG.

Methods: This was a prospective observational study done in the Department of Cardiovascular and Thoracic Surgery in a tertiary center from January 2020 to December 2021 after obtaining Institutional Ethical committee clearance. A sample size was 364 and patients undergoing OPCABG were consecutively recruited in the study.

We evaluated demographic, anthropometric, risk factors, echocardiographic, and peri- and intra-operative variables and CHA2DSSVasc score in patients included in the study. Postoperative AF was established using continuous electrocardiogram monitoring. The predictors we established using regression analysis.

Results: In this prospective study amongst 364 patients recruited, 33 (9.06%) developed AF. Patients who developed AF were older in age with a mean age of 61.22 (8.28) years (p=0.037) compared to those who did not develop AF. CHA2DS2-VASc score cut- off value ≥3 was used and it predicts the development of AF in post CABG patients (OR -1.358, p=0.038). Low ejection fraction 38.22 (9.42)% (p=0.0540) (OR=0.997, p=0.053), increased left ventricular end-systolic dimension (LVESD) 34.38 (8.066) mm (p=0.002) (OR=1.032, p=0.058), increased left ventricular end-systolic dimension (LVEDD 48.35 (5.49) mm (p=0.002) (OR=1.054, p=0.025) were associated with development of AF after OPCABG. However only larger LVEDD, high CHA2DS2-VASc score and advanced age (>60 years) were significant predictors of AF in our study.

Conclusion: In our study advanced age, CHA2DS2-VASc scoring system, and echocardiographic parameters like LVEF, LVEDD, and LVESD appear to be predictors of postoperative AF. Sex, body mass index, hypertension, diabetes, usage of beta-blockers, and left atrial parameters do not appear to be predictors of postoperative AF.

Graphical abstract

Predictors of postoperative atrial fibrillation after off-pump coronary artery bypass grafting - a prospective observational study

Predictors of new-onset atrial fibrillation after of-pump CABG			
Variables	B	Significance	Exp(B)
LVEF	-0.003	0.053	0.997
LVEDD	0.053	0.025	1.054
LVESD	0.031	0.058	1.032
Age (>60 years)	0.045	0.012	0.890
CHA_2DS_2VASC	0.306	0.038	1.358

Key words: predictors, atrial fibrillation, off-pump CABG

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Introduction

Atrial fibrillation (AF) is a common complication that can occur after coronary artery bypass graft (CABG) surgery. The incidence of postoperative AF can vary from 5% to 40% depending on the definition of the arrhythmia, patient characteristics, type of operation, and method of heart rhythm monitoring. Some experts consider postoperative AF to be a benign and self-limited arrhythmia, but it can lead to patient instability, prolong hospital stay, and increase costs. In some cases, AF can even cause perioperative myocardial infarction, stroke, and persistent congestive heart failure (CHF) (1). The use of cardiopulmonary bypass (CPB), the influence of cardioplegia, and myocardial ischemia are possible factors responsible for the postoperative occurrence of AF (2). For the last few years off-pump coronary artery bypass grafting (OPCABG) surgery on the beating heart, without cardiopulmonary bypass has become very popular.

The rapid development of technology for OPCABG, especially stabilizing devices, has made it possible to approach almost all surfaces of the beating heart. Despite excellent short-term results, OPCABG surgery on the beating heart is not completely free from complications. The problem of AF in patients after beating heart surgery is a controversial issue, and literature reviews show that there is a paucity of data from the Indian population examining the predictors of AF (1). Therefore, it is crucial to examine the characteristics that predict new-onset AF in patients undergoing OPCABG in a single medical center in India to better understand and reduce the risk of this complication.

The objective was to estimate the proportion of patients developing AF after off-pump CABG (OPCABG) and to determine the possible predictors of AF after OPCABG.

Methods

Study design and population

This was a prospective observational study conducted for a duration of two years from January 2020 to December 2021 in the U. N. Mehta Institute of Cardiology and Research Center (UNMICRC), Ahmedabad. The sample size was calculated to be 364 cases. Overall, 364 patients undergoing off-pump CABG were included in the study. On pump CABG, and CABG with other concomitant surgery, patients with a past history of AF were excluded from the study.

The study was conducted after Institutional ethical committee clearance (UNMICRC/CVTS/2019/20). A written informed consent was obtained from the patients. They were also informed that the data concerning the case would be submitted for publication and they consented.

Baseline variables

Clinical findings were recorded according to a pre-designed proforma, which had been approved by the institutional Ethics committee. All the details such as demographic (age, sex) and anthropometric (BMI – body mass index) data, risk factors – hypertension, diabetes, history of stroke, transient ischemic attack (TIA), thromboembolism, CHF and left ventricular (LV) dysfunction, vascular diseases, comorbidities, echocardiographic variables left atrial (LA) size, left ventricular end-systolic (LVESD) and left ventricular end-diastolic (LVEDD) dimensions, left ventricular ejection fraction (LVEF), medical therapy were recorded.

Being an observational study, there was no change in the management pattern for the patient.

CABG surgery and postoperative variables

All patients underwent OPCABG surgery. Postoperatively, all of them were monitored in the cardiothoracic recovery room for at least 48 hours under observation followed by 48 hours of observation in a step-down surgical intensive care unit (ICU). Thus, continuous electrocardiographic (ECG) monitoring of all the patients was done for at least 4-5 days postoperatively. Patients who developed new-onset AF were taken into consideration.

All the details such as demographic data, operative data, and development of AF were noted and recorded. One of the scoring systems used was the CHA_2DS_2-VASc score.CHA2DS2-VASc score (congestive heart failure, hypertension, age ≥ 75 years, diabetes mellitus, stroke or transient ischemic attack (TIA), vascular disease, age 65 to 74 years, sex category) is a validated tool to predict the risk of stroke and systemic emboli in a patient with non-valvular AF.

Statistical analysis

Data were entered into an Excel Sheet and analyzed using Microsoft Excel 365 V 2021 Stat Pac. For analytical statistics, the patients were divided into two groups based on the main outcome parameter: patients with AF and patients without AF. For categorical variables, Chi-square and Fisher's exact tests were used after applying tests for normality. For continuous variables, unpaired t test was used to compare variables after applying Kolmogorov-Smirnov test for normality of data distribution.

For determining predictors of AF, the logistic regression analysis was conducted. For CHA2DS2-VASc score the sensitivity and specificity for prediction of AF were calculated as well. To test the significance of difference, 'p' value less than 0.05 is taken to denote significant relationship.

Results

Out of the 750 patients who underwent OPCABG in this institution during the study period, 364 patients were consecutively recruited for this study. Most of the patients belonged to the 51-70 years age group. The average age of the population was 58.1 years, the eldest patient age was 76 years and the youngest patient was 35 years aged. There were 291 males (80%) and 73 females (20%). Most of the patients belonged to the normal BMI range (181 patients) & the obese category (126 patients). Forty-one patients (11.26%) were known cases of chronic obstructive pulmonary disease (COPD). All the patients had a history of aspirin treatment. Only 35 patients were on beta-blockers preoperatively.

As shown in Table 1, all parameters have been given one score except Age>75 years (two scores) and Stroke/TIA/ thromboembolism history (two scores). LV dysfunction was noted in the majority of the patients. Hypertension was noted in 128 patients (35.16%). A history of stroke/thromboembolism was noted in 8 patients (2.19%). Diabetes was noted in 152 patients (34.34%). The most common score was score 3 (119 patients) followed by score 2 (105 patients). Score 4 (73 patients), score 5 (35 patients) and score 1 (31 patients) were less common. Only one patient had a score of 6. There were no patients with a score of 0. In this study group, mean LVEF, LVESD, LVEDD, and LA diameter were 42.62%, 31.09mm, 46.13mm & 29.73 mm respectively. The main outcome variable - new-onset atrial fibrillation was noted in 33(9.06%) patients. In 331 patients, there was no AF.

Table 1. Distribution of parameters used in calculating the CHA2DS2-VASc score

Variables	Present	Absent
CHF history / LV dysfunction	251	113
Age > 75 years (score 2)	13	351
Hypertension history	128	236
Stroke/TIA/thromboembolism history	8	356
Diabetes history	152	212
Vascular disease *	364	0
Age (65 to 74 years)	127	237
Female sex	73	291

CHF - congestive heart failure, LV –left ventricular, TIA - transient ischemic attack
Vascular disease*: prior myocardial infarction, peripheral arterial disease or aortic plaque

As can be seen from Table 2, the average age of the patients who developed AF and who did not develop AF was 65.20 and 57 years respectively. Upon comparing, the difference is statistically significant. This implies that older patients are more likely to develop AF. Echocardiographic parameters LVEF, LVEDD, and LVESD have a strong correlation with the development of AF ($p<0.05$). Mean LA diameter did not appear to have an association with the development of AF ($p=0.16$). Other parameters like sex distribution, BMI, hypertension, diabetes, and beta-blocker usage did not appear to impact the development of AF. Patients with CHA_2DS_2-VASc score 3 or more who developed AF and who did not develop AF were 30 and 303 respectively. Using CHA_2DS_2-VASc score of ≥3, sensitivity is found to be 45.2% and specificity is 71.5%, $p=0.054$. This implies that a CHA_2DS_2-VASc SCORE cut-off of ≥3 should be used and it has an excellent ability to predict the development of AF in post CABG patients. Treatment of AF included the use of beta-blockers, calcium channel blockers, amiodarone, serum potassium correction, and electrical cardioversion.

Table 2. Clinical characteristics in patients with and without postoperative AF

Variables		Developed AF (n=33)	Not developed AF (n=331)	p
Age, years		65.20 (8.28)	57.86 (8.54)	0.037
Sex	Male (291)	25	266	1.0
	Female (73)	6	67	
BMI, kg/m^2		24.77 (3.83)	24.21 (3.98)	0.455
HT	Present	13	115	0.434
	Absent	18	218	
DM	Present	15	137	0.451
	Absent	16	196	
Beta-blocker	Used (n=35)	4	31	0.521
	Not Used (n=329)	27	302	
LVEF, %		39.38 (9.42)	42.92 (9.74)	**0.0540**
LVEDD, mm		48.35 (5.49)	45.92 (4/13)	**0.0026**
LVESD, mm		34.38 (8.066)	30.78 (6.13)	**0.0026**
LA Diameter, mm		30.80 (6.35)	29.63 (4.22)	0.16

AF – atrial fibrillation, BMI - body mass index, DM – diabetes mellitus, HT – hypertension, LA – left atrium, LVESD -left ventricular end-systolic dimension, LVEDD - left ventricular end-diastolic dimension, LVEF - left ventricular ejection fraction

Table 3 shows that old age, LVEF, LVESD, LVEDD, and CHA2DS2-VASc score (≥3) had association with new-onset atrial fibrillation after OPCABG. However only large LVEDD, high CHA2DS2-VASc score and advanced age (>60 years) were significant predictors of AF in our study.

Table 3. Predictors of new-onset atrial fibrillation after OPCABG			
Variables	**B**	**p**	**Exp(B)**
LVEF	-0.003	0.053	0.997
LVEDD	0.053	0.025	1.054
LVESD	0.031	0.058	1.032
Age (>60 years)	0.045	0.012	0.890
CHA2DS2VASC	0.306	0.038	1.358
LVEF - left ventricular ejection fraction LVEDD - left ventricular end-diastolic dimension, LVESD -left ventricular end-systolic dimension, OPCABG – off-pump coronary bypass surgery			

Discussion

Atrial fibrillation is recognized as a major cause of adverse events soon after the introduction of CABG for the treatment of coronary artery disease (1, 2). Atrial fibrillation within first-second postoperative days after CABG is relatively common with a recorded incidence of 20 to 50% and is associated with increased morbidity and, a higher risk of embolic stroke postoperatively (1, 2). Therefore, we conducted this prospective observational study to determine the effect of certain predictors on the incidence of postoperative AF after CABG. The present study included 364 patients with coronary artery disease undergoing CABG. The major findings in this study show that older age, echocardiographic parameters LVEF, LVESD, and LVEDD are the key predictors of the risk for postoperative AF.

It is noted that there is no ambiguity in the impact of old age on the development of postoperative AF. Our study has less than 10% incidence of AF. Saxena et al. (3) and Ben Ahmed et al. (4) also had a low incidence of AF in their study groups. Whereas, there are studies that have reported incidence of up to 40% (6, 7). Erdil et al. (6) and AksoyF et al. (7) revealed an incidence of AF of 14.16 and 32.80%, respectively. It is possible to conclude that old age patients should be prioritized in monitoring for postoperative AF.

There seem to be conflicting opinions regarding the relationship between hypertension and AF. Our study did not show any association, Gorczyca I et al. (8) also noted no association. While Lewicki et al. (9) and Seo et al. (5) noted hypertension and postoperative AF are related. It can be stated that the correlation between hypertension and atrial fibrillation needs further analysis.

For relation between diabetes mellitus and postoperative AF, our study showed no statistical significance. Whereas, Ismail MF et al. (10) and Sabzi et al. (11) showed that the presence of diabetes mellitus increased the risk of AF. However, Gorczyca et al. (8) noted no correlation, and surprisingly, Tennyson et al. (12) noted that higher HbA1c levels were associated with a reduced incidence of postoperative AF. No meta-analysis seems to have been done on this subject. The correlation between diabetes and **AF needs further study.**

Our study noted no statistical significance of BMI with AF development. Similar findings are noted by Straus et al. (13). However, study by Omer et al. (14) showed that a BMI of more than 30 kg/m2 can be a predisposing factor as the higher BMI was associated with 2-fold increase in AF. In our population, it is noted that the correlation between BMI and coronary artery disease is also not as strong as seen in the Western population.

Our study did not show a statistically significant association between COPD and postoperative AF, (p= 0.76). Most of the other studies like Seo et al (5) and Gorczyca I et al. (8) have shown a correlation between COPD and AF development. The reason why our study did not show a correlation was probably that the study was not powered enough to study this association.

Our study and most other studies like Sabzi et al. (11), Ismail et al. (10), and Seo et al. (5) showed the impact of LV dysfunction on the development of AF. One exception to this was a study by Gorczyca I et al. (8). There is a strong correlation between LV function and the development of AF.

In our study, we noted no correlation between LA diameter and the development of AF. This is a surprising finding. Most of the other studies have shown this correlation between LA diameter and the development of AF. This can be improved upon by considering the LA volume index instead of LA diameter or volume. This finding needs further exploration in future studies.

Our study showed association of the usage of the CHA2DS2-VASc scoring system (cut-off value of ≥3, p = 0.054) with the development of AF. While Chua et al. (15) revealed a score > 2 was associated with AF (p-=0.01).

In summary, the study attempted to find the parameters that correlate with the development of postoperative AF. Parameters like age, CHA2DS2-VASc scoring system, and echocardiographic parameters like LVEDD, LVESD, and LVEF were found to be predictive of postoperative AF. Parameters like gender, BMI, hypertension, diabetes, usage of beta blockers, and left atrial parameters were not found to be predictive of postoperative AF.

Study limitations

This was a single-center study. We did not evaluate the mid and long-term outcomes of the patients. Continuous ECG recording was not performed after ICU discharge and asymptomatic AF may have been missed.

Conclusion

In our study, the prevalence of postoperative AF after off-pump CABG is around 9.06%. Age, CHA2DS2-VASc scoring systems, and echocardiographic parameters like LVEF, LVEDD, and LVESD appear to be predictive of postoperative atrial fibrillation. Gender, BMI, hypertension, diabetes, usage of beta blockers, and left atrial parameter do not appear to be predictors of postoperative atrial fibrillation.

Ethics: A written informed consent was obtained from the patients. They were also informed that the data concerning the case would be submitted for publication and they consented. This study was approved by the institutional ethics committee (UNMICRC/CVTS/2019/20).

Peer-review: External and internal

Conflict of interest: None to declare

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