Original Article

Prospective Evaluation of the Utility of CHA_2DS_2-VASc Score in the Prediction of Postoperative Atrial Fibrillation after Off-pump Coronary Artery Bypass Surgery – An Observational Study

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Abstract

Introduction: Off-pump coronary artery bypass (OPCAB) surgery is associated with evasion of complications of cardiac bypass. The incidence of postoperative atrial fibrillation (POAF) may also be reduced because of less ischemia and inflammation. **Aim:** Prospective evaluation of utility of CHA_2DS_2-VASc score in the prediction of POAF after OPCAB surgery. **Methodology:** In this prospective, observational study, 99 patients who underwent elective isolated OPCAB surgery were included. Patients with pacemaker *in situ*, receiving antiarrhythmic drugs preoperatively, and preexisting atrial fibrillation were excluded. A detailed history taking and physical examination were done preoperatively and the CHA_2DS_2-VASc scores were calculated for each patient. They received a standard anesthetic including midazolam, fentanyl, propofol, vecuronium, and isoflurane. The number of grafts, inotrope usage, and blood product transfusion in the perioperative period were noted. Patients were followed up for 5 days after surgery for development of new onset POAF requiring treatment. **Results:** About 20 of the 99 patients developed POAF. POAF occurred most commonly on postoperative day 2. They were older, more likely diabetic, had preoperative diastolic dysfunction, and received blood products perioperatively. POAF group had higher mean CHA_2DS_2-VASc score (3.6 ± 0.821 vs. 2.11 ± 1.35) and had longer hospital stay (16.85 ± 8.61 vs. 12.6 ± 4.05 days) than no POAF group. The cutoff for CHA_2DS_2-VASc score was 3, which showed 90% sensitivity, 77.22% specificity, 50% positive predictive value, and 96.63% negative predictive value. **Conclusions:** CHA_2DS_2-VASc score is useful in predicting POAF after OPCAB surgery. Higher the CHA_2DS_2-VASc score, greater is the possibility of development of POAF.

Keywords: *CHA_2DS_2-VASc score, coronary artery bypass graft, postoperative atrial fibrillation*

Introduction

Coronary revascularization is the cornerstone in the management of patients with ischemic heart disease. Off-pump surgery is defined as coronary artery bypass graft (CABG) surgery on the beating heart without using cardiopulmonary bypass (CPB) and cardiac arrest, regardless of the surgical access to the heart. Postoperative atrial fibrillation (POAF) has been described in up to 5%–40% of patients in the early postoperative period (within 2–4 days postoperatively with a peak incidence on day 2) after CABG surgery.[1] The evasion of CPB is related with a notable reduction in the inflammatory response and in the release of markers of myocardial necrosis in contrast to conventional CABG.[2] There is a hypothesis that off-pump CABG may decrease the incidence of POAF through decreased trauma, ischemia, and inflammation. Developing a practical and simple score that can predict POAF can possibly reduce patient morbidity. CHA_2DS_2-VASc score is recommended to guide antithrombotic therapy in patients with atrial fibrillation/flutter.[3] This prospective observational study was done to evaluate the utility of CHA_2DS_2-VASc score in the prediction of atrial fibrillation after off-pump coronary artery bypass (OPCAB) surgery.

Methodology

This was a prospective observational study. All patients were operated by a single surgical team. The study commenced after approval from department dissertation and institutional ethics committee. Waiver of consent from patients was granted since it was an observational study. All the

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patients who underwent elective isolated OPCAB surgery during the period from January 2015 to December 2015 were included. Patients with pacemaker *in situ*, those on antiarrhythmic drugs preoperatively (verapamil, diltiazem, amiodarone, and digoxin), and those with preexisting atrial fibrillation were excluded.

Preoperative evaluation was done by the principal investigator on the day prior to surgery, which included detailed history taking and physical examination. The CHA_2DS_2-VASc scores were calculated for each patient. Results of investigations such as complete blood count, renal function test, liver function test, coagulation profile, 12-lead ECG, ECHO, stress tests (if done), and carotid Doppler and coronary angiogram were noted down. Use of medication such as β-blockers, angiotensin converting enzyme inhibitor (ACEI)/angiotensin receptor blockers (ARB), and statins were also noted down. β-Blockers and statins were continued till the day of surgery. All patients were premedicated with tablet lorazepam 0.5 mg orally except in patients with poor LV function and heart failure. They were counseled in their language about the surgical procedure, anesthetic plan, and postoperative morbidity [Table 1].

Monitoring included five electrode ECGs, monitoring lead II and V5, pulse oximetry, and noninvasive blood pressure. Oxygen at 5 L/min was administered with a simple oxygen face mask. Large bore intravenous (IV) line was secured after local anesthetic infiltration. Mild sedation and analgesia was achieved with IV midazolam 1–2 mg and IV fentanyl 25–50 μg. A triple lumen central venous catheter was preferably inserted into right internal jugular vein after local anesthetic infiltration. Radial artery was preferably cannulated under local anesthesia and monitoring of intra-arterial pressures was commenced. Pulmonary artery catheter was used for patients with poor left ventricular function [Ejection fraction (EF) of 30%]. Hematocrit, arterial blood gas analysis, random blood sugar, and activated clotting time were obtained in all patients before induction of anesthesia.

Anesthesia was induced with IV midazolam 0.1–0.15 mg/kg and IV fentanyl 4–8 μg/kg. Neuromuscular blockade was achieved with IV vecuronium 0.1 mg/kg or IV atracurium 0.5 mg/kg. Preservative-free 2% lignocaine 1.5 mg/kg was given 90 s prior to endotracheal intubation to attenuate cardiovascular responses to laryngoscopy and tracheal intubation. Depth of anesthesia was maintained using titrated doses of isoflurane and IV infusion of propofol at 70–100 μg/kg/min with intermittent doses of IV fentanyl at 1.5–2 μg/kg for analgesia. The details of number of grafts, inotrope usage, and blood product transfusion in the perioperative period were noted.

Table 1: The definitions of acronym CHA2DS2-VASc

Parameter	Score
Congestive cardiac failure/LV systolic dysfunction	1
Hypertension	1
Age ≥75 years	2
Diabetes mellitus	1
Stroke/TIA/Thromboembolism	2
Vascular disease (Prior MI/PVD/CAD)	1
Age 65-74 years	1
Sex category (female)	1

Patients were observed for 5 days after the surgery for the development of new onset POAF defined as new electrocardiography evidence of AF requiring treatment. The timing and treatment of POAF were noted down.

All patients with POAF were treated with IV amiodarone 150 mg bolus over first 10 min followed by IV infusion of 1 mg/min over next 6 h and 0.5 mg/min over next 18 h. After 24 h of infusion, patients were started on tablet. Amiodarone 200 mg TID continued for next 1 month.

The initial episode of atrial fibrillation in all patients lasted for 24–48 h. No patient required electric cardioversion and there was zero percent mortality. Prophylactic anticoagulants were started in high-risk group prone for thromboembolism.

The sample size was calculated based on the results of a pilot study on 20 patients. Six out of 20 patients had developed POAF. The mean composite score in patients who developed POAF was 3.5 and those who did not was 2.86. With the level of significance at 0.05, power of study 80%, and for a difference in composite score of 1 between those who develop POAF and those who do not, a total of 99 patients were required to be enrolled into this study.

Continuous variables are described as mean with standard deviation and are compared between groups by using independent *t*-test. Dichotomous variables were presented as percentages and compared between groups by Chi-square test or Fisher exact test. For primary analysis, all demographic, surgical, and medication utilization variables with a $P \leq 0.2$ in univariate analysis were entered into a stepwise forward multivariate logistic regression model with POAF as the binary dependent outcome. The area under the receiver operating characteristic (ROC) curve was calculated to test discriminatory power of CHA_2DS_2-VASc score to predict POAF.

Results

Ninety-nine patients were enrolled into the study with 20 patients developing POAF in the 5-day follow-up period.

Patients who developed atrial fibrillation (POAF) were older with higher mean age of 67.05 years than the patients who did not ($P < 0.001$). Height, weight, and gender distribution were comparable in both the groups [Table 2]. POAF group had higher prevalence of diabetes mellitus (80%) ($P < 0.0026$) as shown in Table 3.

Table 4 illustrates the CHA_2DS_2-VASc scoring in both the groups. POAF group had higher mean scores (3.60 ± 0.821) than no POAF group (2.11 ± 1.35) ($P < 0.0001$). Table 5 illustrates the various preoperative investigations in both groups. The serum creatinine was slightly higher and diastolic dysfunction was more frequent in patients who developed POAF.

Table 6 illustrates various intraoperative finding and medical therapy in both the groups. Blood product transfusion was higher in patients who sustained POAF ($P = 0.017$).

Patients who developed POAF had a longer hospital stay (16.85 ± 8.61 days) than no POAF group (12.60 ± 4.05 days) ($P = 0.0017$) [Table 7].

Timing of postoperative atrial fibrillation

Atrial fibrillation occurred most frequently on the postoperative day (POD) 2 (11 patients – 55%) followed by POD 3 (4 patients – 20%) and POD 1 (3 patients – 15%) [Figure 1].

ROC curve for the CHA_2DS_2-VASc scores showed an area of 0.82 [Figure 2], which was statistically significant ($P < 0.0001$).

A multiple regression was run to predict POAF from various variables with P value less than 0.2. However, only CHA_2DS_2-VASc score was statistically significant ($P < 0.001$). The odds ratio (OR) for predicting POAF was highest with a higher CHA_2DS_2-VASc scores (2.324, 95% confidence intervals [CI]: 1.512–3.574). The cutoff for CHA_2DS_2-VASc score was 3, which showed a sensitivity of 90% and specificity of 77.22% with positive predictive value of 50% (95% CI: 32.92–67.08) and negative predictive value of 96.63% (95% CI: 89%–99.61%).

Discussion

The main finding of the present study was that CHA_2DS_2-VASc score is useful in predicting POAF after

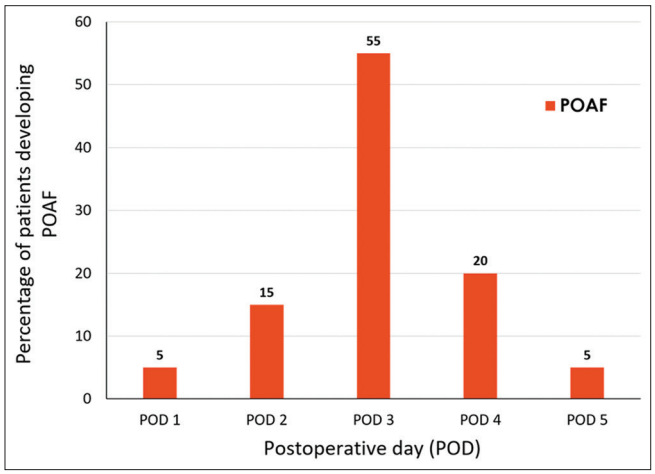

Figure 1: Timing of postoperative atrial fibrillation after OPCAB

Table 2: Demographic details

Demographic variables	POAF (*n*=20)	No POAF (*n*=79)	*P*
Age (years) (mean±SD)*	67.05±6.6	60.04±8.8	0.0012
Weight (kg) (mean±SD)*	63.88±10.48	60.39±10.40	0.1818
Height (cm) (mean±SD)*	160.84±8.42	157.60±7.44	0.0935
Female *n* (%)#	4 (20%)	20 (25.3%)	0.7740

*Student's *t*-test, #Chi-square test

Table 3: Medical history [*n* (%)]

	Total (*n*=99)	POAF (*n*=20)	No POAF (*n*=79)	*P*
Congestive cardiac failure*	5 (5.1%)	3 (15%)	2 (2.5%)	0.0547
Hypertesnion*	68 (68.7%)	17 (85%)	51 (64.6%)	0.1063
DM*	49 (49.5%)	16 (80%)	33 (33.3%)	0.0026
Stroke/Transient ischaemic accident*	10 (10.1%)	2 (10%)	8 (10.1%)	1
Myocardial infarction (MI)*	25 (25.3%)	7 (35%)	18 (22.8%)	0.2641
Peripheral vascular disease*	3 (3%)	1 (5%)	2 (2.5%)	0.4958
Coronary artery disease*	12 (12.1%)	4 (20%)	8 (10.1%)	0.2545

*Chi-square test

Table 4: CHA_2DS_2-VASc score and POAF

	POAF (*n*=20)	No POAF (*n*=79)	*P*
CHA_2DS_2-VASc score (mean±SD)*	3.60±0.821	2.11±1.35	0.0001

*Student's *t*-test

Table 5: Preoperative investigations

Parameters	POAF (*n*=20)	No POAF (*n*=79)	*P*
Serum creatinine (mg/dL)*	1.14±0.356	0.99±0.25	0.0312
EF (%)*	55.9±8.416	58.09±9.873	0.3646
Diastolic dysfunction#	14 (70%)	28 (35.4%)	0.01
No. of stenosed coronaries*	3.3±0.80	3.68±1.08	0.1442
Significant LMCA disease#	3 (15%)	28 (35.4%)	0.1063

*Student's *t*-test, #Chi-square test, LMCA: Left main coronary artery

Table 6: Intraoperative findings and medical therapy

Parameters	POAF (*n*=20)	No POAF (*n*=79)	*P*
No. of grafts*	3.85±0.875	3.99±0.824	0.535
Blood products#	12 (60%)	23 (29.1%)	0.017
Inotropes#	18 (90%)	65 (82.3%)	0.5144

*Student's *t*-test, #Chi-square test

Table 7: Length of ICU and hospital stay

	POAF (*n*=20)	No POAF (*n*=79)	*P*
Total ICU stay (days)*	3.65±1.46	3.25±1.59	0.2972
Total hospital stay (days)*	16.85±8.61	12.60±4.05	0.0017

*Student's *t*-test

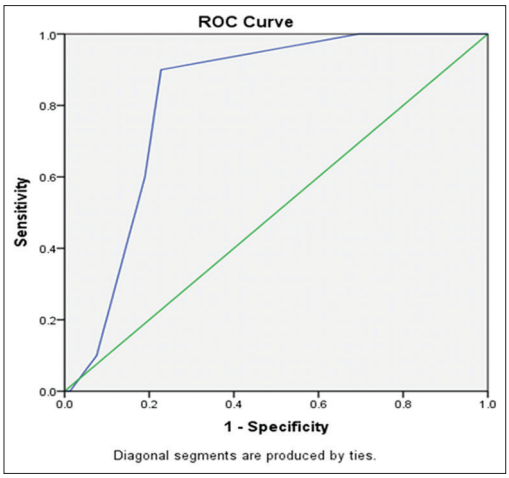

Figure 2: ROC curve of CHA_2DS_2-VASc scores and POAF

off-pump CABG (OPCAB). This scoring system is simple and convenient to use in the preoperative period to alert the clinician about higher probability of POAF after OPCAB. Numerous causative factors such as an increase in circulating catecholamines, enhanced sympathetic and parasympathetic tone, atrial dilatation and stretch, transcellular fluid and electrolyte relocation, metabolic abnormalities, inflammation, and pericarditis have been described without any single factor being singled out as cause of this complication. Owing to the complex etiology, it is difficult to predict this complication in the postoperative period.

In a prospective observational study carried out in 70 centers located within 17 countries with 4657 patients, Mathew *et al*. developed a multicenter study of perioperative ischemia atrial fibrillation risk index with variables including age, history of AF, chronic obstructive pulmonary disease, concurrent valve surgery, and withdrawal of postoperative β-blockers or ACEI/ARBs.[4] These factors were included in a model that assigned points from −25 to +60. A nomogram correlated point score with the probability of developing postoperative AF. In this study, the postoperative variables included were withdrawal of β-blockers/angiotensin converting enzyme inhibitors in the postoperative period, postoperative potassium supplementation, and postoperative nonsteroidal anti-inflammatory drug use. The inclusion of these postoperative variables limits the applicability of this scoring system in the preoperative period.

Amar *et al*. studied 1553 patients who underwent isolated on-pump CABG to create a simple risk model for the prediction of POAF.[5] Multivariate analysis showed that older age (OR 1.1 per year increment [95% CI: 1.0–1.1], $P < 0.0001$; estimated coefficient 0.054, point score 1 per 1-year increment), history of AF (OR 3.7 [95% CI: 2.3–6.0], $P < 0.0001$; estimated coefficient 0.654, point score 12), *P*-wave duration 110 ms (OR 1.3 [95% CI: 1.1–1.7], $P < 0.02$; estimated coefficient 0.142, point score 3), and postoperative low cardiac output (OR 3.0 [95% CI: 1.7–5.2], $P < 0.0001$; estimated coefficient 0.547, point score 10) were independently associated with AF risk. A nomogram then correlated point score with AF probability with three risk categories for AF. The area under the ROC curve for the model was 0.69. The inclusion of postoperative low cardiac output and calculation of *P*-wave duration in this algorithm limit its value as a practical preoperative assessment tool for POAF. In contrast, CHA_2DS_2-VASc score can be applied in the preoperative period.

Chami *et al*. constructed a postcardiac surgery AF risk prediction tool using only preoperative variables in a large cohort of more than 18,000 patients and further validated this tool in a sequential cohort of nearly 1400 patients.[6] Their model included different cutoff age, height, weight, and presence of peripheral vascular disease based on gender. Patients were scored on a scale of 0–4 based on these factors. The rate of AF ranged from 10% in the lowest score group (score of 0) to 38.9% in their highest score group (score of 4). However, the study is limited to a single center and applicability of this score in a global context may be questionable as demographics of patients differ significantly among regions.

CHA_2DS_2-VASc score is recommended to guide antithrombotic therapy in patients with AF or atrial flutter. Each component of the $CHADS_2$ and CHA_2DS_2-VASc scores has been associated with the ventricular remodeling, left ventricle diastolic dysfunction, and left atrial enlargement that may lead to atrial arrhythmia. Two recent reports used this score to predict the risk of POAF.

Chua *et al*. in a risk stratification study of 277 patients found that the $CHADS_2$ and CHA_2DS_2-VASc scores were significant predictors of POAF in separate multivariate regression analysis. The Kaplan–Meier analysis indicated a higher POAF rate when based on the $CHADS_2$ and CHA_2DS_2-VASc scores of at least 2 than when based on scores <2 (both log rank, $P < 0.001$).[7]

Similarly, in our study when ROC curve was obtained for the CHA_2DS_2-VASc scores, area of 0.82 was obtained, which was statistically significant ($P < 0.0001$). However in our study, the cutoff for CHA_2DS_2-VASc score was 3. In a nested case-control study, Baker *et al*. studied 560 patients undergoing CABG and/or valvular surgery from the AF suppression trials I–III.[8] The authors reported POAF in 177 patients (31.6%), with 27%, 23%, and 41% in the low (0–1), medium (1–3), and high (>3) CHA_2DS_2-VASc score groups, respectively. The high-score group had 2.3-fold increased odds of developing AF versus the medium-score group ($P < 0.0001$).

Our study also identified CHA_2DS_2-VASc score as a significant predictor of POAF with OR of 2.34 on multivariate regression analysis. To reduce confounding, multivariate logistic regression was done to control

most known predictors of POAF. Consequently, other predictors that may have been related to development of POAF could have been eliminated. Only patients undergoing OPCAB were included since the utility of CHA_2DS_2-VASc score in patients undergoing on-pump CABG has already been shown in a previous study. The limitations of our study were that it was unblinded and was a single-center study.[3]

Conclusions

CHA_2DS_2-VASc score is useful in predicting POAF after OPCAB surgery. Higher the CHA_2DS_2-VASc score, greater is the possibility of development of POAF. The cutoff of CHA_2DS_2-VASc score is 3 and has a high sensitivity of 90% and negative predictive value of 96.63% (95% CI: 89%–99.61%). The specificity is 77.2%, but the positive predictive value is 50% (95% CI: 32.92–67.08).

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Conflicts of interest

There are no conflicts of interest.

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