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Original Research Article

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

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ABSTRACT

Background: 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 post-operative AF after CABG. 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 of a tertiary center from December 2019 to December 2020 after obtaining Institutional review board clearance. A sample size of 334 was fixed and patients undergoing OPCABG were consecutively recruited in the study. The association of preoperative and postoperative factors with occurrence of AF were analysed using the univariate analysis with a p value <0.05 using the SPSS 16 software. Multivariate analysis was done to determine the independent predictors after OPCABG.
Results: In this prospective study amongst the 334 patients recruited 60 (18%) developed atrial fibrillation and the maximum incidence was seen on the third postoperative day. Patients who developed AF were older with mean age of 61.38±7.63 years, 2.96 (95% CI 0.71-5.21) as compared to those who did not develop AF. Male gender Odds ratio 1.17 (95%CI 1.06-1.31), low ejection fraction 54.95±10.47, -3.25 (95% CI-5.99- -0.52); large atrial size 3.45±0.42, 0.12 (95% CI 0.02-0.06); long intensive care unit (ICU) stay 2.47±0.59, 0.32 (95% CI 0.06-0.21) and long hospital stay 7.62±3.36, 1.48 (95% CI 0.44-0.59) were associated with development of AF after OPCABG. Older age was found to be an independent predictor of development of AF on doing multivariate analysis.
Conclusions: In our study advanced age was found to be an independent predictor of atrial fibrillation after OPCABG. Males, low ejection fraction, large atrial size and longer ICU and hospital stays were associated with occurrence of AF after OPCABG.

Keywords: Predictor, Atrial fibrillation, Off pump CABG

INTRODUCTION

Atrial fibrillation (AF) is the most common complication after coronary artery bypass graft (CABG) surgery. Incidence of postoperative AF varies from 5 to over 40% according to definition of the arrhythmia, patients' characteristics, type of operation and method of heart rhythm monitoring.[1] Some investigators consider postoperative AF to be a benign and self-limited arrhythmia. It rarely has a fatal outcome, however may lead to instability of the patient, prolongs hospital stay and increases costs. In some cases, AF can be the reason of perioperative myocardial infarction, stroke, and persistent congestive heart failure.[1]

The use of cardiopulmonary bypass (CPB), the influence of cardioplegia and myocardial ischemia are possible factors responsible for postoperative occurrence of AF.[2] For last few years off-pump coronary artery bypass (OPCABG) surgery on the beating heart, without

cardiopulmonary bypass has become very popular. Rapid development of technology for OPCABG, especially stabilizing devices, has made it possible to approach almost all surfaces of the beating heart. OPCABG has excellent short-term results, however is not completely free from complications. The problem of AF in patients after beating heart surgery appears to be controversial.[1]

Literature review shows that there is paucity of data from the Indian population which examine the predictors of AF in the Indian population. Hence the rationale of this study was to examine the characteristics that might predict new-onset AF in patients undergoing OPCABG in a single medical center in India.

METHODS

This was a prospective observational study done in the department of cardiovascular and thoracic surgery from December 2019 to December 2020. Approval was obtained from the institutional research committee and institutional review board (IRB no. 103/2018 dated 28.02.2019). From study by Arribas-Leal et al, the incidence of postoperative AF following CABG was 23%, so sample size of 334 was fixed.[3] All patients with single and multi-vessel disease patients undergoing elective OPCABG surgery during this period were included in the study after obtaining informed consent. Patients with recent ischemic attack and chronic renal failure were excluded from the study. All OPCABG patients were carefully watched during the perioperative period and postoperatively for 7 days for the occurrence of AF and the details were filled in structured proforma. In this study AF was defined to be sustained if persisting >10 minutes and only such AF were recorded. For the purpose of analysis, only a first event was recorded. Statistical analysis was done using statistical package for the social sciences (SPSS) version 16.0. Descriptive data was expressed using median, mean or percentages and frequencies. The association of intraoperative and postoperative variables with occurrence of AF were analysed using the univariate analysis with a p value <0.05.

RESULTS

Out of the 731 patients who underwent OPCABG in this institution during the study period, three hundred and thirty-four patients were consecutively recruited for this study. The proportion of patients who developed post-operative AF was 60 (18%).The mean age was 58.96±8.1 years and there were 70 (21%) females and 264 (79%) males. While 33 (9.9%) developed AF on the third postoperative day, 20(6%) developed it on the 2nd day, four (1.2%) developed AF on the first day and 3 (0.9%) developed it on the 4th post-operative day.

The non-AF and AF group were compared in terms of demographic, preoperative and postoperative factors. Table 1 summarizes the pre-operative continuous variables. On doing independent t test we could see a statistically significant difference in the age, ejection fraction, left atrial size, intensive care unit (ICU) stay and total hospital stay amongst the AF and non-AF groups.

Table 2 summarizes the association of categorical variables with AF. Chi square test was done to evaluate binary variables and Mann Whitney U test where there were more than 2 groups.

Table 1: Pre-operative and post-operative continuous variables.

Variables	AF group (n=60)	Non-AF group (n=274)	P value	Mean difference (95% CI)
Age (years)	61.38±7.63	58.43±8.11	0.01	2.96 (0.71-5.21)
Ejection fraction	54.95±10.47	58.20±9.59	0.02	-3.25 (-5.99-0.52)
Left atrial size	3.45±0.42	3.33±0.44	0.05	0.12 (0.02-0.06)
Heart Rate	71.03±9.45	72.91±10.02	0.18	-1.87 (-4.65-0.97)
Preop Na	137.37±3.32	137.97±3.88	0.26	-0.60 (-1.66-0.46)
Preop K	4.055±0.5788	4.177±0.4617	0.08	-0.12 (-0.26-0.01)
HbA1C	7.085±1.78	6.949±1.65	0.57	0.14 (-0.33-0.61)
Distal graft number	2.82±0.54	2.73±0.64	0.37	0.08 (-0.09-0.25)
Postop K	3.63±0.36	3.7±0.39	0.21	-0.07 (0.05-0.18)
Intercostal drain	409.5±202.7	399.38±180.77	0.70	10.12 (26.37-41.75)
ICU stay	2.47±0.59	2.14±0.38	<0.001	0.32 (0.06-0.21)
Total hospital stay	7.62±3.36	6.14±1.61	0.001	1.48 (0.44-0.59)

Table 2: Preoperative categorical variables.

Variables	AF group (n=60)	Non-AF group (n=274)	P value	OR (95% CI)
Gender (male)	54 (90)	210 (76.6)	0.021	1.17 (1.06-1.31)
Smoking	42 (70)	144 (52.6)	0.014	1.33 (1.09-1.63)
Diabetes	39 (65)	176 (64.2)	0.911	1.01 (0.82-1.24)

Continued.

Variables	AF group (n=60)	Non-AF group (n=274)	P value	OR (95% CI)
Hypertension	29 (48.3)	139 (50.7)	0.737	0.95 (0.72-1.27)
Dyslipidaemia	1 (1.7)	19 (6.9)	0.119	0.24 (0.03-1.76)
Hypothyroidism	4 (6.7)	13 (4.7)	0.54	1.41 (0.48-4.16)
Cerebrovascular accidents	3 (5)	10 (3.6)	0.62	1.37 (0.39-4.82)
Previous MI	11 (18.3)	63 (23)	0.43	0.79 ()0.45-1.41)
LM involvement	17 (28.3)	77 (28.1)	0.97	1.01 (0.65-1.57)
LIMA-LAD graft	58 (96.7)	261 (95.3)	0.63	1.10 (0.96-1.07)
VG-OM	52 (86.7)	240 (87.6)	0.85	0.99 (0.89-1.10)
Triple vessel disease	52 (86.7)	233 (85)	0.75	1.02 (0.91-1.14)
Perioperative inotrope	59 (98.3)	250 (91.2)	0.05	1.08 (1.02-1.13)

Table 3: Results of multivariate analysis for prediction of independent risk factors.

Regression weights	B coefficient	R2	T value	P value
Age >60 years	0.091	0.042	2.166	0.031
Gender (male)	0.078	0.062	1.254	0.211
LA size >4	0.070	0.077	0.907	0.365
Ejection fraction <40	0.007	0.110	0.060	0.952
Smoking	0.066	0.050	1.300	0.194
Perioperative inotrope	0.150	0.079	1.886	0.060

There was a significant association of age, gender, ejection fraction, left atrial size, smoking and perioperative inotrope use in patients developing AF as shown in Tables 1 and 2. Multivariate analysis was performed to evaluate the relationships between the development of postoperative AF and its risk factors by adjusting for other independent variables that may also be related to AF. The multivariate analysis was conducted using a logistic regression model, and the results revealed that the risk of developing postoperative AF was 4.9% with predictors like age, gender, ejection fraction, left atrial size, smoking and perioperative inotrope use collectively (F (6,327) =2.83, p=0.011).

$$Predicted\ score = 1.18 + 0.091\ (age\ 60) + 0.078\ (male) + LA\ size > 4\ (0.70) + ejection\ fraction < 40\ (0.007) + smoking\ (0.066) + perioperative\ inotrope\ use\ (0.15)$$

Age >60 years found to be the only predictor with statistical significance (β-0.091, t=2.166, p=0.03).

DISCUSSION

This was a high-volume single center study. Over the last 20 years, the incidence of AF after CABG has been consistently reported between 10 to 50%. AF may lead to increased risk of hemodynamic compromise, prolonged hospitalization, and increased risk for cerebral thromboembolism.[3] In this study the proportion of patients who developed AF was 18% which peaked on the third followed by the second postoperative day. This is consistent with a study by Lewicki et al in which 18.3% ONCABG and 19.3% OPCABG patients developed AF and they also observed that the peak incidence of arrhythmia was on the second and third postoperative day.[4] Perrier et al reported an AF incidence of 21% and Arribas-Leal et al reported an incidence of 23% with on pump CABG.[3,5] This shows that there is no much variation in the incidence of AF in patients undergoing on pump versus off pump CABG. However, a meta-analysis showed that there was a significant reduction of AF in the OPCABG group.[6]

The pathophysiology of postoperative AF is multifactorial. Previous studies have implicated age-related degenerative change, perioperative inflammatory response and electrophysiological abnormality of atrial cells as causes of AF.[2] The electrophysiologic mechanism of postoperative AF is believed to be reentry that results from dispersion of atrial refractoriness. When adjacent atrial areas have dissimilar or non-uniform refractoriness, a depolarizing wavefront becomes fragmented as it encounters both refractory and excitable myocardium. This allows the wavefront to return and stimulate previously refractory but now repolarized myocardium leading to incessant propagation of the wavefront or reentry. Currently, there is not an adequate explanation for why some patients develop postoperative AF whereas others having the same surgical interventions remain in sinus rhythm.[1] Omer et al says that both on -pump and off-pump CABG activate the inflammatory cascade and myocardial ischemia itself activates the inflammatory cascade and might contribute to the development of POAF.[7]

The mean age of patients who developed AF was 61.38±7.63 as compared to 58.43±8.11 years in those who had a sinus rhythm which was statistically significant (p=0.01). This was comparable to study by Lewicki et al in which the mean age of those who developed AF was 60.8±8.9 years as compared to

62.6±10.2 years in those who did not develop AF, however it was not statistically significant.[4]

Shah et al found that the mean age was 67±3.24 years in those who with AF and it was 59.9±3.62 years in those without AF which was statistically significant.[8] In this study age >60 years found to be a significant predictor of AF in patients on OPCABG. Ismail et al stated that the incidence of post-operative AF was 7% in patients less than 60 years, 18% between 60 and 70 years and reached up to 42% for patients above the age of 70 years.[9] Age has been recognized an independent predictor of AF and various reasons like degenerative changes in atrium and presence of comorbidities.[10-12]

Male gender was found to have a higher risk 1.17 (1.06-1.31) of developing AF with 90% developing AF being males. However, on doing multivariate analysis. It was eliminated as a predictor of AF. Perrier et al stated that female sex was not a predictor of postoperative AF and Lewicki et al found that the proportion of females who developed AF was more than that of males.[4,5] In a study by Ismail et al 69% patients who developed AF were males while 61.9% who did not develop AF were males which was not significant.[9] In line with this study Stewart et al, found that age and gender were associated with AF.[13]

Seventy percentage of the patients who developed AF were smokers in comparison to non-AF group with a significant p value 0.014 with an OR 1.33 (95% CI 1.09-1.63). Smoking has been found to be an important modifiable risk factor for cardiovascular diseases as nicotine may induce pro-arrhythmic atrial fibrosis resulting in increased susceptibility to catecholamines.[14]

Left atrial size and ejection fraction were found to be associated with AF on univariate analysis. However, on multivariate analysis left atrial size >4 and ejection fraction <40 were not found to be independent predictors in this study. Ismail et al found that left atrial size, atrial volume, depressed left ventricular function and high post-operative heart rate have been associated with increased incidence of post-operative AF.[9] Levya et al found that there was no correlation between left atrial size and AF assuming that dysfunctional left atrium was distinct of atrial remodeling.[15]

ICU stay and total hospital stay were also associated with AF, however they were eliminated as independent predictors of AF in this study. The mean ICU stay was 2.47±0.59 days and the mean total stay was 7.62±3.36 days. Velioglu et al found that patients with AF had statistically significant longer lengths of ICU stay and hospital stay than those without AF.[16] Worsening of hemodynamic status due to AF and the possible complications and its treatment are found to be the cause of the longer ICU stay and hospital stay.

Limitations

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

CONCLUSION

The results of our study demonstrated that age was an independent predictor for the development of AF who underwent OPCABG. In addition, post-operative AF was associated with male gender, large atrial size, low ejection fraction and longer lengths of ICU and hospital stays. However, further studies with larger sample size and longer postoperative monitoring need to be done to support the immediate and long-term outcomes in patients who develop AF postoperatively.

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