Original Article

# Incidence and risk factors for development of atrial fibrillation after cardiac surgery under cardiopulmonary bypass

**Address for correspondence:**
Dr. Sona Dave,
4/C Bindiya, Reclamation Area, Bandra West,
Mumbai - 400 050,
Maharashtra, India.
E-mail: sonadave@gmail.com

**Access this article online**

Website: www.ijaweb.org

DOI: 10.4103/ija.IJA_6_18

Quick response code

*Sona Dave, Anand Nirgude, Pinakin Gujjar, Ritika Sharma*

**Department of Anaesthesiology, Topiwala National Medical College and BYL Nair Charitable Hospital, Mumbai, Maharashtra, India**

## ABSTRACT

**Background and Aims:** Atrial fibrillation (AF) is a common postoperative complication after cardiac surgery due to multifactorial causes. The aim of this study was to evaluate the incidence and risk factors of postoperative atrial fibrillation (POAF) after cardiac surgery under cardiopulmonary bypass (CPB). **Methods:** A total of 150 adult patients undergoing coronary artery bypass graft (CABG) surgery and valvular surgeries were included. They were evaluated with respect to preoperative risk factors [age, use of β-blockers, left ventricular ejection fraction (LVEF), previous myocardial infarction (MI) and diabetes], intraoperative factors (CABG or valvular surgery, duration of CPB and aortic cross clamp time) and postoperative factors (duration of inotropic support and ventilatory support). Outcome measure was POAF after cardiac surgery under CPB. Postoperative intensive care unit and hospital stay and mortality were also studied. **Results:** Of the patients who developed POAF, 50% were less than 60 years, 50.6% were diabetics, 50.7% had prior MI,19.7% had LVEF <40%, 82.6%were not on β-blockers, 66.7% had aortic cross clamp time >60 min and 60% had surgery with CPB time >100 min. About 38.8% underwent CABG and 43.1%underwent valvular surgery. There was a positive association with LVEF <40%, prior MI, post-bypass inotropic support greater than 10 min and ventilatory support more than 24 h with the development of POAF. **Conclusion:** The incidence of POAF after cardiac surgery was 40.7%. Preoperative LVEF <0.4, prior MI, CPB time >100 minand extended ventilation for >24 h were significantly associated with POAF.

**Key words:** CABG, cardiopulmonary bypass, postoperative atrial fibrillation, valvular surgery

## INTRODUCTION

The incidence of postoperative atrial fibrillation (POAF) ranges between 10% and 65%.[1,2] in cardiac surgical patients. This is associated with increased rate of postoperative complications such as congestive heart failure, renal insufficiency, thromboembolic events and stroke, which prolong the length of hospital stay, increase rates of rehospitalisation and the overall cost of hospitalisation.[3] Postoperative delirium and neurocognitive decline have also been associated with it.[4] Myocardial ischemia and inadequate cardioplegic protection of the atria increase the incidence of POAF.[5]

The aim of this study was to evaluate the incidence and risk factors of POAF after cardiac surgery under cardiopulmonary bypass (CPB).

## METHODS

After obtaining approval from the Ethics Committee, we included 150 adult patients undergoing coronary artery bypass graft (CABG) and valvular surgery using cardiopulmonary bypass (CPB) over a period of 1 year. Data were collected prospectively from cardiovascular



**How to cite this article:** Dave S, Nirgude A, Gujjar P, Sharma R. Incidence and risk factors for development of atrial fibrillation after cardiac surgery under cardiopulmonary bypass. Indian J Anaesth 2018;62:887-91.

surgery operation theatre and intensive care unit (ICU) for this observational descriptive study. Patients with chronic AF and those undergoing cardiac surgeries other than CABG and valve replacement were excluded. Since no similar studies were conducted in the past in this institute, the sample size was calculated based on the cardiac surgical workload of the hospital.

The predictors of POAF which were studied include preoperative parameters such as age >60 years, left ventricular ejection fraction (LVEF) <40%, prior diabetes (fasting plasma glucose level 126 mg/dL or random plasma glucose greater than 200 mg/dLor patient on chronic antidiabetic treatment), prior myocardial infarction (MI), chronic obstructive pulmonary disease and use of beta blocker therapy. Intraoperative parameters included were type of surgery (valvular or CABG), aortic cross clamp time >60 min and CPB time >100 min. Duration of postoperative inotropic support >30 min and postoperative ventilatory support >24 h were also considered.

The outcome was POAF which was documented from detection of AF on the lead II of cardioscope and was correlated with the risk factors.The length of hospital stay and mortality were also studied.

A binomial logistic regression was performed to predict the association of multiple risk factors contributing to AF. Both unadjusted and adjusted odds ratios are reported. IBM SPSS Statistics V.13 and Microsoft Excel were used for analysis and graphical representation, respectively.

## RESULTS

The mean age of the patients was 46.7 years with a standard deviation of 13.3 years, and the male-to-female ratio was 70:80. The incidence of POAF in the study group was 40.7%.(61 patients)

Tables 1-3 show the distribution of risk factors and the association of AF with the risk factors, respectively. Non-use of β blockers preoperatively was associated with lower odds of developing atrial fibrillation (OR 0.153) and the association is significant (*P* value: 0.004). Patients with LVEF >/=40% had lower odds of developing atrial fibrillation [OR 0.174; 95% confidence interval (CI) 0.032-0.952] and the association is significant ($P = 0.04$). Also, those patients who did not require inotropic support for more than 30 minutes postoperatively had lower odds of developing atrial fibrillation (OR 0.127; 95% CI 0.028-0.576)) and the association is highly significant ($P = 0.007$).

**Table 1: Distribution of risk factors among the study groups**

| Risk factors | Patients with these risk factors | |
|---|---|---|
| | Number | Percentages |
| Age >60 years | 46 | 30.7 |
| LVEF <40% | 46 | 30.7 |
| Preoperatively on β blockers | 127 | 84.7 |
| COPD | 4.5 | 3 |
| DM | 70 | 47.3 |
| MI | 90 | 60 |
| Valve surgery | 64.99 | 43.3 |
| CABG | 85.00 | 56.7 |
| Aortic cross clamp time >60 min | 45 | 30 |
| CPB time >100 min | 49.99 | 33.3 |
| Ventilation support >24 h | 15 | 10 |
| Post CPB inotropic support >6 h | 42 | 28 |

LVEF – Left ventricular ejection fraction; COPD – Chronic obstructive pulmonary disease; DM – Diabetes mellitus; MI – Myocardial infarction; CABG – Coronary artery bypass graft; CPB – Cardiopulmonary bypass

The odds of having AF were 6.27 times higher among those with prior MI ($P = 0.04$). Also the odds of having AF were 12.28 times higher in those in whom ventilator support was present for more than 24 h ($P = 0.023$).

Tables 4 and 5 show the distribution of patients developing AF at various timelines and the association of AF with increased hospital stay and mortality, respectively.

## DISCUSSION

POAF remains a frequent complication of CABG and valvular surgeries. We found that the majority of the initial episodes of AF occurred within the first 3 days after cardiac surgery with peak incidence on the second postoperative day. Aranki *et al.*and Funk*et al.* also endorsed similar findings.[5,6]

Proposed mechanisms such as pericardial inflammation, autonomic imbalance during the postoperative period, excessive production of catecholamines and a fluid shift with resultant changes in volume and pressure are all contributory to the development of POAF.[7,8]

The danger of AF is related to the rapid heart rate, irregular rhythm, loss of atrial kick and risk of atrial thrombosis. These can be treated by electrical or pharmacological conversion from AF to sinus rhythm followed by antiarrhythmic medication to

**Table 2: Incidence of POAF in pts with various risk factors**

| Risk factors | No of cases (Out of total 150) | No of cases with POAF | Incidence of POAF (%) if risk factor present* |
|---|---|---|---|
| Age >60 y | 46 | 09 | 19.56 |
| DM | 83 | 42 | 50.6 |
| MI | 75 | 38 | 50.7 |
| LVEF <40% | 71 | 14 | 19.7 |
| COPD | 5 | 0 | 0 |
| Preop B blockers | 127 | 42 | 33.1 |
| Aortic cross clamp time >60 min | 45 | 30 | 66.7 |
| CPB time >100 min | 50 | 30 | 60 |
| CABG | 85 | 33 | 38.8 |
| Valve surgery | 65 | 28 | 43.1 |
| Post CPB int. sup >30 min | 42 | 19 | 45.2 |
| Ventilator support >24 h | 15 | 05 | 33.3 |

*Percentages are calculated from the total number of patient with the risk factor. POAF – Postoperative atrial fibrillation; DM – Diabetes Mellitus; MI – Myocardial infarction; LVEF – Left ventricular ejection fraction COPD – Chronic obstructive lung disease; CPB – Cardiopulmonary bypass – CABG Coronary artery bypass grafting

**Table 3: Multivariate analysis showing association of postoperative atrial fibrillation with risk factors**

| Factor | Category | POAF *n* (%) | OR (95% CI) | Adjusted OR (95% CI) | *P* |
|---|---|---|---|---|---|
| Age | <60 | 6 (13) | 0.43 | 1 | 0.628 |
| | >60 | 27 (26) | (0.16-1.12) | 0.68 (0.14-3.26) | |
| β-blockers | Yes | 24 (18.9) | 0.36 | 1 | 0.004 |
| | No | 9 (39.1) | (0.14-0.94) | 0.15 (0.04-0.54) | |
| LVEF <40% | Yes | 11 (15.1) | 0.44 | 1 | 0.044 |
| | No | 22 (28.6) | (0.20-0.997) | 0.17 (0.03-0.95) | |
| Myocardial Infarction | Yes | 19 (26) | 1.58 | 1 | 0.04 |
| | No | 14 (18.2) | (0.73-3.46) | 6.27 (1.08-36.26) | |
| Diabetes | Yes | 18 (21.7) | 0.96 | 1 | 0.66 |
| | No | 15 (22.4) | (0.44-2.09) | 0.77 (0.24-2.47) | |
| CABG | Yes | 15 (17.9) | 0.58 | 1 | 0.980 |
| | No | 18 (27.3) | (0.27-1.26) | 1.02 (0.18-5.81) | |
| Valvular surgeries | Yes | 18 (27.3) | 1.73 | 1 | 0.980 |
| | No | 15 (17.9) | (0.79-3.76) | 1.02 (0.18-5.81) | |
| Duration CPB | Yes | 18 (27.3) | 1.73 | 1 | 0.980 |
| | No | 15 (17.9) | (0.79-3.76) | 1.02 (0.18-5.81) | |
| Aortic cross clamp time | Yes | 21 (46.7) | 0.15 | 1 | 0.999 |
| | No | 12 (11.4) | (0.06-0.34) | 0 (0.00-0.00) | |
| Inotopic support | Yes | 9 (20.9) | 0.92 | 1 | 0.007 |
| | No | 24 (22.4) | (0.39-2.17) | 0.13 (0.03-0.58) | |
| Ventilator support | Yes | 5 (35.7) | 2.14 | 1 | 0.023 |
| | No | 28 (20.6) | (0.67-6.90) | 12.28 (1.42-106.08) | |
| COPD | Yes | 1 (3) | 0.88 | 1 | 0.819 |
| | No | 4 (3.4) | (0.095-8.18) | 0.58 (0.005-64.20) | |

POAF – Postoperative atrial fibrillation; CI – Confidence interval; OR – Odds ratio; LVEF – Left ventricular ejection fraction; CABG – Coronary artery bypass graft; CPB – Cardiopulmonary bypass; COPD – Chronic obstructive pulmonary disease. *Values in the column "Atrial fibrillation" are numbers (percent)

maintain sinus rhythm. Alternatively, rate control and anticoagulation without conversion to sinus rhythm can be used.[9]

Advanced age has been the most consistent predictor of POAF.[10] In a study done by Mathew *et al.*,[4] it was found that every 10-year increase in age is associated with a 75% increase in the odds of developing AF. Thus, on the basis of age alone, anyone older than 70 years is considered to be at high risk for developing AF. However, in our study the incidence of POAF was more in valvular surgical patients, and since these patients were younger in age there was a preponderance of incidence in the younger age group [Table 2]. This was coupled by the fact that CABG patients presented at younger age group in our institution.

In our study, previous history of MI was strongly associated with development of POAF although diabetes was not. In 1996, Aranki*et al.*[5] found that patients with previous history of MI are at greater risk of POAF after cardiac surgery. Mueller *et al.*[8] studiedAF and minimally invasive CABG and found that diabetes was strongly associated with development

**Table 4: Time of occurrence of postoperative atrial fibrillation among study subjects**

| Time of occurrence of POAF | Yes | No |
|---|---|---|
| Intraoperative | 23 (15.3) | 127 (84.7) |
| Postoperative Day1 | 27 (18) | 123 (82) |
| Postoperative Day 2 | 42 (28) | 108 (72) |
| Postoperative Day 3 | 32 (21.3) | 118 (78.7) |

POAF – Postoperative atrial fibrillation. Figures in parenthesis indicate percentages

**Table 5: Association of increased hospital stay and mortality with POAF in subjects**

| | POAF | | *P* |
|---|---|---|---|
| | Yes | No | |
| Increased hospital stay | | | |
| Yes | 48 (84.2) | 9 (15.8) | <0.01 |
| No | 13 (14) | 80 (86) | |
| Mortality | | | |
| Yes | 6 (75) | 2 (25) | 0.098 |
| No | 55 (38.7) | 87 (61.3) | |

POAF – Postoperative Atrial Fibrillation. Figures in parenthesis indicate percentages. {$\chi^2$=72.24, df=1, *P*=0.0} {df=1, *P*=0.098}

of POAF. Since our study had a mixed population with a large number of valvular surgical patients who were younger, we did not find a significant correlation between the two.

In studies by Zaman *et al.* and Yi-Ting Tsai *et al.*, there was a significantly lower incidence of POAF in patients on β-blockers.[9,10] Sympathetic activation or an exaggerated response to adrenergic stimulation may be an important trigger for POAF.[11] Therefore, β-blockers, by antagonising the sympathetic activity, serve to protect against it. In our study there was a definite association between those patients not taking β-blockers and the development of atrial fibrillation (OR -0.153). However we could not directly prove the protective effect of β-blockers.

LVEF <40%in the preoperative period was strongly associated with development of POAF ($P < 0.005$). Valve surgery and CABG surgery are associated with an increased risk of AF. Although the incidence of AF after valve surgery was more than that in patients undergoing CABG surgery in our study, statistical tests showed no significant difference in the incidence of POAF in between valvular surgery and CABG surgery [Table 2]. Almassi *et al.* studied AF after cardiac surgery and found that incidence of POAF was 27.5% after CABG, 48.8%after mitral valve replacement (MVR), 32.9% after aortic valve replacement (AVR), 36.4% after CABG + AVR and the maximum incidence was 60% following CABG + MVR.[12] The possible explanation could be a result of structural and hemodynamic abnormalities such as left atrial enlargement, pathological changes from rheumatic heart disease, increased left atrial pressure and surgical trauma.

It was seen from our study that patients who underwent cardiac surgery with prolonged aortic cross clamp time (>60 min) and CPB time(>100 min) had higher incidence of POAF ($P < 0.001$).Helgadottir *et al.* and Hashemzadeh *et al.* also noted similar findings.[13,14] CPB is associated with an ischemia-reperfusion injury inducing a complex inflammatory response, the analogous of which have been reported in patients with AF. These range from the presence of inflammatory infiltrates in atrial biopsies to increased concentrations of C-reactive protein which form the substrate for generation of ectopic activity.[15,16]

The need for using inotropic agents in the postoperative period is related to two major factors: the preoperative degree of myocardial dysfunction and intraoperative events such as inadequate myocardial protection, incomplete revascularisation and technical difficulties. Our data show that if inotropic support was needed beyond 30 mins after termination of CPB, although the difference was not statistically significant, the incidence of AF was higher than those who required it for <30 min. Hashemzadeh*et al.* in their study on POAF following open cardiac surgery found that post-CPB inotropic support for >30 min was the single most important postsurgical predictor of POAF.[13]

When extended ventilation was needed in the postoperative period, in our patients, it was associated with increased incidence of POAF. Aranki *et al*. in their study have documented these findings.[5] Causative agents may be hypoxia, hypovolemia, sepsis and electrolyte imbalances.[17]

In our study, patients with AF had a longer median stay in the ICU >3 days in comparison to patients in sinus rhythm who got discharged on the third day. This may be related to the need for stabilisation of hemodynamic status, correction of hypoxia, need for ventilatory support or a combination of all. Other authors like Creswell *et al.* and Aranki *et al.* have found similar association.[8,3] The increase in the cost of hospitalisation makes it imperative to design strategies to prevent the occurrence of AF, to treat it effectively once it develops and to initiate prophylactic anticoagulation protocols for prevention of embolic

strokes. AF increased the median postoperative hospital stay from 7 days in patients in sinus rhythm to >7 days in those who developed POAF. Although we did not analyze the actual hospital costs per patient, it is clear that an increase in hospital stay will significantly drive up the cost of hospitalisation. Above all, there was an increased mortality also because of POAF than mortality because of other cause (4% vs 1.33%). Almassi *et al.* found the incidence of POAF to be 29.6% and the in-hospital mortality was 6% after surgery, for patient with POAF when compared with 3% for patients with no POAF ($P < 0.002$).[10]

Most of these patients would revert to sinus rhythm within 6 weeks, and electrical cardioversion could be done on an outpatient basis for the few patients who do not revert despite pharmacological treatment.[17] Such an approach would result in a considerable reduction in length of stay in hospital and significant cost reduction.

The limitations of our study were that both CABG and valve surgeries were included. In addition, the sample size was not calculated and arbitrarily chosen on the basis of our workload. The cost burden on those patients could also not be calculated.

## CONCLUSION

The peak incidence of POAF after cardiac surgery was on the second postoperative day with the incidence being 40.7% in our study. A low preoperative EF (<0.4%), prior MI, CPB time >100 min and extended ventilation for >24 h showed a significant association with POAF. It also increased hospital stay and mortality in study subjects.

### Financial support and sponsorship
Nil.

### Conflicts of interest
There are no conflicts of interest.

## REFERENCES

1. Patti G, Chello M, CanduraD, PasceriV, D'AmbrosioA, Covino E, *et al.* Randomized trial of atorvastatin for reduction of postoperative atrial fibrillation in patients undergoing cardiac surgery: results of the ARMYDA-3 (Atorvastatin for Reduction of Myocardial Dysrhythmia After cardiac surgery) study. Circulation 2006;114:1455-61.
2. Alqahtani AA. Atrial fibrillation post cardiac surgery trends toward management. Heart Views 2010;11:57-63.
3. Kalman JM, Munawar M, Howes LG, Louis WJ, Buxton BF, Gutteridge G. *et al.* Atrial fibrillation after coronary artery bypass grafting is associated with sympathetic activation. Ann ThoracSurg 1995;60:1709-15.
4. Mathew JP, Fontes ML, Tudor IC, Ramsay J, Duke P, Mazer CD, *et al.* A multicenter risk index for atrial fibrillation after cardiac surgery. JAMA 2004;291:1720-9.
5. Aranki SF, Shaw DP, Adams DH, Rizzo RJ, Couper GS, Vander Vliet M, *et al.* Predictors of atrial fibrillation after coronary artery surgery. Circulation 1996;94:390-7.
6. Funk M, Richards SB, Desjardins J, Bebon C, Wilcox H. Incidence, timing, symptoms, and risk factors for atrial fibrillation after cardiac surgery. Am J Crit Care 2003;12:424-33.
7. Fuster V, Rydén LE, Asinger RW, Cannom DS, Crijns HJ, Frye RL, *et al.* ACC/AHA/ESC guidelines for the management of patients with atrial fibrillation. J Am Coll Cardiol 2001;38:19.
8. Mueller XM, Tevaearai HT, Ruchat P, Stumpe F, Von Segesser LK. Atrial fibrillation and minimally invasive coronary artery bypass grafting: A risk factor analysis. World J Surg 2002;26:639-42.
9. Zaman AG, Archbold RA, Helft G, Paul EA, Curzen NP, Mills PG. Atrial fibrillation after coronary artery bypass surgery: A model for preoperative risk stratification. Circulation 2000;101:1403-8.
10. Tsai YT, Lai CH, Loh SH, Lin CY, Lin YC, Lee CY. Assessment of the risk factors and outcomes for postoperative atrial fibrillation patients undergoing isolated coronary artery bypass grafting. Acta Cardiol Sin 2015;31:436-43.
11. Banach M, Rysz J, Drozdz JA, Okonski P, Misztal M, Barylski M, *et al*. Risk factors of atrial fibrillation following coronary artery bypass grafting: A preliminary report. Circ J 2006;70:438-41.
12. Almassi GH, Schowalter T, Nicolosi AC, Aggarwal A, Moritz TE, Henderson WG, *et al.* Atrial fibrillation after cardiac surgery: A major morbid event? Ann Surg 1997;226:501-11.
13. Helgadottir S, Sigurdsson MI, Ingvarsdottir IL, Arnar DO, Gudbjartsson T. Atrial fibrillation following cardiac surgery: Risk analysis and long-term survival. J CardiothoracSurg 2012;19:87.
14. Hashemzadeh K, Dehdilani M, Dehdilani M. Postoperative atrial fibrillation following open cardiac surgery: Predisposing factors and complications. J Cardiovasc Thorac Res 2013;5:101-7.
15. Archbold RA, Schilling RJ. Atrial pacing for the prevention of atrial fibrillation after coronary artery bypass graft surgery: A review of the literature. Heart 2004;90:129-33.
16. Hogue CW, Domitrovich PP, Stein PK, Despotis GD, Re L, Schuessler RB. RR interval dynamics before atrial fibrillation in patients after coronary artery bypass graft surgery. Circulation 1998;98:429-34.
17. Nystrom U, Edvardsson N, Berggren H, Pizzarelli GP, Radegran K. Oralsotalol reduces the incidence of atrial fibrillation after coronary artery bypass surgery. Thorac Cardiovasc Surg 1993;41:34-7.