

Original Research Article

EVALUATION OF POSTOPERATIVE ATRIAL FIBRILLATION IN CABG PATIENTS: INCIDENCE, RISK FACTORS, AND OUTCOMES

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ABSTRACT

Background: Postoperative atrial fibrillation (POAF) is a common complication following coronary artery bypass grafting (CABG) and is associated with increased morbidity, prolonged hospitalization, and adverse clinical outcomes. Despite advances in surgical techniques and perioperative management, POAF remains prevalent, and its risk factors continue to evolve. The objective is to determine the incidence of POAF after isolated CABG and to identify associated and independent risk factors in the current era.

Materials and Methods: This retrospective observational study included 1500 adult patients who underwent isolated CABG between March 2015 and January 2023. Patients with preoperative atrial fibrillation or concomitant cardiac procedures were excluded. POAF was defined as atrial fibrillation lasting >30 seconds, documented by continuous electrocardiographic monitoring, and requiring medical treatment. Demographic, clinical, echocardiographic, and perioperative variables were analyzed. Univariate analysis identified potential risk factors, and variables with $p < 0.10$ were entered into a multivariate logistic regression model to identify independent predictors of POAF.

Results: POAF occurred in 468 patients (31.2%). Patients who developed POAF were significantly older and had lower left ventricular ejection fraction (EF). On univariate analysis, age, hypertension, smoking, cardiopulmonary bypass (CPB) time, and EF were significantly associated with POAF. Multivariate logistic regression identified advanced age (OR 1.058 per year; 95% CI 1.038–1.079; $p < 0.001$) and reduced EF (OR 0.982 per % increase; 95% CI 0.969–0.996; $p = 0.01$) as the only independent predictors. The use of CPB and surgical technique (on-pump vs off-pump CABG) were not independent risk factors.

Conclusion: POAF remains a frequent complication after isolated CABG. Advanced age and reduced ejection fraction are the primary independent predictors of POAF, whereas surgical technique does not significantly influence its occurrence. Targeted perioperative monitoring and preventive strategies should be emphasized in high-risk patients.

Keywords: Postoperative atrial fibrillation; Coronary artery bypass grafting; Ejection fraction; Cardiopulmonary bypass; Risk factors; Off-pump CABG; On-pump CABG.

INTRODUCTION

New-onset postoperative atrial fibrillation (POAF) remains one of the most frequent complications following coronary artery bypass grafting (CABG)

and continues to be associated with increased morbidity, prolonged hospital stay, higher healthcare costs, and adverse long-term outcomes.^[1-3] Despite advances in surgical techniques, anesthesia, and perioperative care, the reported

incidence of POAF after CABG remains substantial, ranging from 20% to 50% across different populations and healthcare settings.^[4]

POAF typically occurs within the first few postoperative days, with a peak incidence around postoperative day two, and is expected to increase further due to the aging surgical population and the growing burden of cardiovascular comorbidities.^[5,6] Several mechanisms have been proposed for POAF development, including atrial ischemia, inflammation, autonomic imbalance, oxidative stress, and pre-existing structural and functional cardiac abnormalities.

Multiple studies have attempted to identify predictors of POAF after CABG; however, the reported risk factors remain inconsistent. Advanced age, reduced left ventricular ejection fraction (EF), hypertension, smoking, prolonged cardiopulmonary bypass (CPB) time, and surgical technique (on-pump versus off-pump) have all been implicated, with variable strength of association across studies.^[7–10] Moreover, as surgical practices evolve and perioperative management improves, previously established risk factors may change in relevance over time.

Therefore, contemporary data evaluating POAF risk factors in the current era are essential for risk stratification and targeted prevention strategies.

Aim

To evaluate the incidence of postoperative atrial fibrillation and identify its associated risk factors in patients undergoing isolated coronary artery bypass grafting.

Objectives

1. To determine the incidence of POAF after isolated CABG in the current era.
2. To analyze demographic, clinical, and perioperative variables associated with POAF.
3. To identify independent predictors of POAF using multivariate logistic regression analysis.

MATERIALS AND METHODS

Study Design and Patient Selection: This retrospective observational study included 1500 consecutive adult patients who underwent isolated CABG surgery between March 2015 and January 2023 at a tertiary-care cardiac centre. All patients were in sinus rhythm prior to surgery.

The study protocol was approved by the Institutional Review Board, and the study was conducted in accordance with the Declaration of Helsinki.

Inclusion Criteria

- Age ≥ 18 years
- Isolated CABG surgery
- Sinus rhythm before surgery

Exclusion Criteria

- History of atrial fibrillation or other arrhythmias
- CABG combined with valve or other cardiac procedures
- Incomplete medical records

Patients were categorized into:

- POAF group: patients who developed postoperative atrial fibrillation
- Non-POAF group: patients who remained in sinus rhythm

Demographic data, comorbidities, preoperative echocardiographic parameters, and intraoperative variables were obtained from the Hospital Information System.

Surgical Technique: CABG procedures were performed under general endotracheal anesthesia. The choice between on-pump CABG and off-pump coronary artery bypass (OPCAB) was based on patient characteristics and surgeon preference.

- OPCAB procedures utilized heart stabilizers, intracoronary shunts, and partial aortic clamping for proximal anastomoses.
- On-pump CABG employed standard cardiopulmonary bypass with ascending aortic and right atrial cannulation. CPB flow was maintained at approximately 2 L/m²/min, with mean arterial pressure between 50–80 mmHg. Moderate hypothermia (32–34°C) was used.
- Myocardial protection was achieved using warm blood cardioplegia (Buckberg) administered via antegrade and retrograde routes.

Complete revascularization was attempted in all patients, with preferential use of the left internal mammary artery for the left anterior descending artery whenever feasible.

Definition of POAF: POAF was defined as atrial fibrillation lasting more than 30 seconds, documented by continuous electrocardiographic monitoring or rhythm strips, occurring at any time from surgery until hospital discharge, and requiring pharmacological treatment (most commonly amiodarone).

Statistical Analysis: Statistical analysis was performed using SPSS version 26.0.

- Continuous variables were expressed as mean $\pm$ standard deviation (SD) and compared using Student's t-test.
- Categorical variables were expressed as number (percentage) and compared using the χ^2 test.
- Variables with $p < 0.10$ on univariate analysis were entered into a stepwise multivariate logistic regression model.
- Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated.

A p value < 0.05 was considered statistically significant.

RESULTS

Study Population and Baseline Characteristics: A total of 1500 adult patients undergoing isolated CABG were included in the study.

Postoperative atrial fibrillation (POAF) occurred in 468 patients (31.2%), while 1032 patients (68.8%) remained in sinus rhythm.

The mean number of grafts per patient was 3.52 ± 0.88 .

Univariate Analysis of Risk Factors for POAF:

Patients who developed POAF were significantly older, had lower left ventricular ejection fraction (EF), higher prevalence of hypertension and

smoking, and longer cardiopulmonary bypass (CPB) time.

Sex, BMI, diabetes, cross-clamp time, and surgical technique (on-pump vs OPCAB) were not significantly associated with POAF.

Table 1: Perioperative Demographic Characteristics and Risk Factors (Univariate Analysis)

Variable	Non-POAF (n=1032)	POAF (n=468)	p value
Age (years)	61.4 $\pm$ 8.6	65.1 $\pm$ 7.8	<0.001
Male sex (%)	70.1	72.4	0.29
BMI (kg/m ²)	25.3 $\pm$ 3.1	25.2 $\pm$ 3.0	0.48
Hypertension (%)	65.8	73.3	<0.001
Diabetes mellitus (%)	28.6	29.9	0.63
Smoking (%)	43.9	49.1	0.03
CPB use (%)	70.4	73.1	0.21
CPB time (min)	92.6 $\pm$ 32.8	96.8 $\pm$ 34.5	0.01
Cross-clamp time (min)	76.8 $\pm$ 31.4	78.1 $\pm$ 29.6	0.34
EF (%)	60.9 $\pm$ 8.4	59.4 $\pm$ 9.3	0.004

POAF patients were older and had lower EF. Hypertension, smoking, and longer CPB time showed significant univariate associations, whereas surgical technique did not influence POAF occurrence.

Multivariate Logistic Regression Analysis:

Variables significant on univariate analysis were entered into a multivariate logistic regression model. Advanced age and reduced EF emerged as independent predictors of POAF.

Table 2: Multivariate Logistic Regression Analysis for POAF

Variable	Odds Ratio (OR)	95% CI	p value
Age (per year increase)	1.058	1.038 – 1.079	<0.001
EF (per % increase)	0.982	0.969 – 0.996	0.01
Hypertension	1.29	0.98 – 1.70	0.07
Smoking	1.19	0.89 – 1.60	0.23
CPB time	1.002	0.998 – 1.006	0.31

After adjustment, only age and EF independently predicted POAF, while hypertension, smoking, and CPB time lost statistical significance.

Subgroup Analysis

Age-Wise Distribution of POAF: POAF incidence increased progressively with advancing age.

Table 3A. Incidence of POAF by Age Group

Age group (years)	POAF (%)
≤ 45	15.1
46–50	16.4
51–55	19.6
56–60	26.9
61–65	30.4
66–70	35.2
71–75	42.7
≥ 75	48.1

A strong age-dependent rise in POAF incidence was observed, confirming advanced age as a major determinant of postoperative atrial fibrillation.

Ejection Fraction Subgroup Analysis: Lower EF was associated with a higher incidence of POAF.

Table 3B: Incidence of POAF by Ejection Fraction

EF (%)	POAF (%)
≤ 50	41.0
51–55	40.8
56–60	37.6
61–65	34.1
≥ 65	31.9

Patients with impaired left ventricular function demonstrated significantly higher rates of POAF, reinforcing EF as an independent predictor.

Surgical Technique and POAF: The incidence of POAF was 30.2% in OPCAB patients and 31.8% in

on-pump CABG patients, with no statistically significant difference ($p = 0.19$).

The use of cardiopulmonary bypass was not an independent risk factor for POAF in this cohort.

Results Summary

In this retrospective cohort of 1500 patients undergoing isolated CABG, POAF occurred in 31.2% of patients. Advanced age and reduced ejection fraction were identified as independent predictors of POAF. Although hypertension, smoking, and longer CPB time were associated with POAF on univariate analysis, they were not independent predictors after multivariate adjustment. The use of cardiopulmonary bypass did not significantly influence POAF incidence.

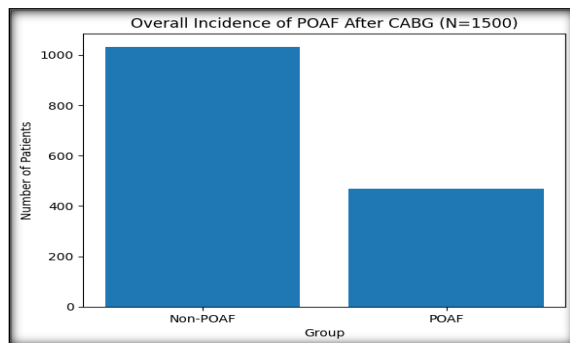


Figure 1: Overall Incidence of POAF After CABG

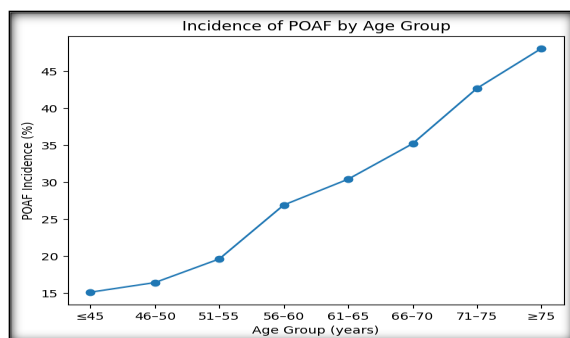


Figure 2: Incidence of POAF by Age Group

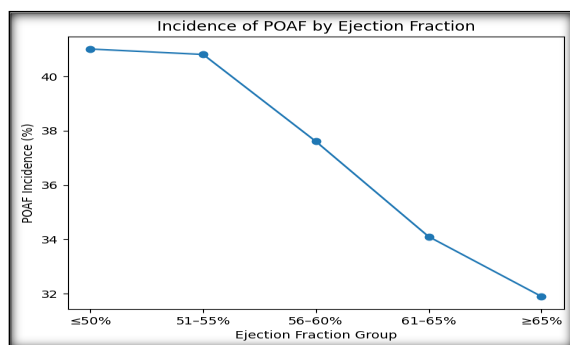


Figure 3: Incidence of POAF by Left Ventricular Ejection Fraction

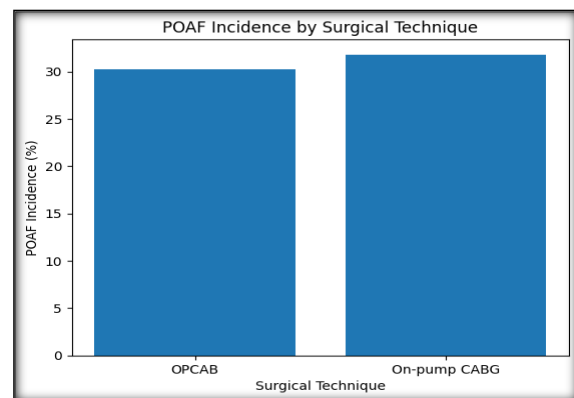


Figure 4: POAF Incidence by Surgical Technique

DISCUSSION

Postoperative atrial fibrillation (POAF) remains one of the most common complications following coronary artery bypass grafting, even in the contemporary era of cardiac surgery. In the present retrospective cohort of 1500 patients undergoing isolated CABG, POAF occurred in 31.2% of patients. This finding reinforces the persistent clinical relevance of POAF and highlights the need for continued refinement of perioperative risk stratification and preventive strategies.

Incidence of POAF in the Current Era

The observed POAF incidence of approximately one-third of patients is consistent with previously reported rates ranging from 20% to 50%.^[4] Despite improvements in surgical techniques, myocardial protection strategies, anesthesia, and perioperative monitoring, POAF continues to impose a significant postoperative burden. Studies have suggested that the aging surgical population and increasing prevalence of cardiovascular comorbidities may offset technical advancements, resulting in a sustained high incidence of POAF.^[5,6]

Our findings are in line with contemporary reports that emphasize POAF as an unresolved clinical issue rather than a declining complication, underscoring the importance of identifying robust and reproducible predictors in modern CABG cohorts.

Advanced Age as an Independent Risk Factor:

One of the principal findings of the present study is that advanced age emerged as the strongest independent predictor of POAF. Patients in the POAF group were significantly older than those who remained in sinus rhythm, and subgroup analysis demonstrated a clear stepwise increase in POAF incidence with advancing age.

This observation is consistent with large epidemiological studies demonstrating that both the prevalence and incidence of atrial fibrillation increase exponentially with age.^[15] Zoni-Berisso et al. reported that AF prevalence rises from <0.2% in individuals younger than 50 years to more than 10% in those older than 80 years.^[15] Similar age-dependent associations have been reported in CABG-specific populations.^[16,17]

Mechanistically, aging is associated with atrial structural remodeling, fibrosis, conduction slowing, and heightened inflammatory and oxidative stress responses, all of which predispose to atrial arrhythmogenesis. The consistent identification of age as an independent predictor across studies—including ours—suggests that advanced age should be considered a cornerstone variable in any POAF risk prediction model.

Left Ventricular Ejection Fraction and POAF: Another major finding of the present study is that reduced left ventricular ejection fraction (EF) independently predicted POAF. Although the absolute difference in mean EF between POAF and non-POAF patients was modest, the association remained statistically significant after multivariate adjustment, and subgroup analysis demonstrated a progressive rise in POAF incidence with decreasing EF.

These results are in strong agreement with previous investigations reporting an association between impaired ventricular function and POAF.^[11,22–24] Li et al. demonstrated that patients with reduced EF had a significantly higher likelihood of developing POAF, potentially reflecting more advanced myocardial damage and atrial vulnerability.^[11] Similarly, Turkkolu et al. highlighted the role of echocardiographic parameters, including EF, in identifying patients at increased arrhythmic risk after cardiac surgery.^[22]

From a pathophysiological perspective, reduced EF is often accompanied by elevated atrial pressures, atrial dilation, neurohormonal activation, and myocardial fibrosis, all of which create a substrate favorable for atrial fibrillation. Our findings further support the incorporation of EF assessment into perioperative risk stratification and individualized preventive strategies for POAF.

Hypertension and Smoking: Significant but Not Independent: In the present study, hypertension and smoking were significantly associated with POAF on univariate analysis but did not retain independent significance in the multivariate model. This pattern suggests that these factors may contribute indirectly to POAF development rather than acting as primary determinants.

Hypertension has been widely recognized as a contributor to atrial remodeling and fibrosis and has been incorporated into several POAF prediction scores.^[17] In our cohort, hypertensive patients exhibited a higher POAF incidence; however, the association weakened after adjustment for age and EF. Similar findings have been reported in other studies, where hypertension lost significance once stronger covariates were accounted for.^[9,17]

Smoking has also been implicated as a risk factor for POAF, potentially through systemic inflammation and oxidative stress.^[18,19] While smokers in our study had a higher unadjusted incidence of POAF, smoking did not emerge as an independent predictor, aligning with reports that suggest its effect may be mediated through

associated comorbidities rather than a direct arrhythmogenic mechanism.

Cardiopulmonary Bypass and Surgical Technique: The role of cardiopulmonary bypass in POAF development remains controversial. Some investigators have reported a lower incidence of POAF in patients undergoing off-pump CABG compared to on-pump procedures, suggesting that avoidance of CPB-related inflammatory responses may reduce arrhythmic risk.^[20,21]

In contrast, our study did not demonstrate a statistically significant difference in POAF incidence between on-pump CABG and OPCAB, nor did CPB duration emerge as an independent predictor in multivariate analysis. Although CPB time was slightly longer in POAF patients and reached significance on univariate analysis, its effect was attenuated after adjustment.

These findings are consistent with reports indicating that patient-related factors such as age and ventricular function may play a more dominant role than surgical technique alone.^[16,20] Our results suggest that while CPB-related mechanisms may contribute to POAF, they are insufficient to independently predict its occurrence in contemporary practice.

Sex and POAF: Sex was not significantly associated with POAF in the present study. Although male patients exhibited a numerically higher incidence, the difference did not reach statistical significance in either univariate or multivariate analyses.

This finding contrasts with population-based data showing a higher prevalence of atrial fibrillation in males,^[15] but aligns with several CABG-specific studies where sex did not consistently predict POAF.^[9,16] The discrepancy may reflect differences between “lone” AF in the general population and POAF, which is more strongly influenced by perioperative and structural cardiac factors.

Clinical Implications: The present findings have important clinical implications. Identification of advanced age and reduced EF as independent predictors of POAF emphasizes the need for heightened surveillance and targeted preventive strategies in these high-risk groups. Early rhythm monitoring, judicious use of beta-blockers or amiodarone, and optimization of perioperative hemodynamics may help reduce POAF-related morbidity.

Limitations: This study is limited by its retrospective, single-center design, which may introduce selection bias. Additionally, although a comprehensive range of clinical and perioperative variables was analyzed, unmeasured confounders cannot be excluded. Prospective multicenter studies are warranted to validate these findings and refine predictive models for POAF.

CONCLUSION

In this contemporary cohort of patients undergoing isolated coronary artery bypass grafting, postoperative atrial fibrillation remains a frequent complication, affecting nearly one-third of patients. Despite ongoing advances in surgical techniques and perioperative care, the burden of POAF continues to be substantial.

The present study demonstrates that advanced age and reduced left ventricular ejection fraction are the only independent predictors of POAF after CABG. Although hypertension, smoking, and longer cardiopulmonary bypass time were associated with POAF on univariate analysis, these factors did not retain independent significance after multivariate adjustment. Importantly, the choice of surgical technique—on-pump versus off-pump CABG—did not significantly influence the incidence of POAF.

These findings underscore the critical importance of preoperative risk stratification, particularly in elderly patients and those with impaired ventricular function. Focused perioperative monitoring and individualized preventive strategies in these high-risk groups may help mitigate the clinical impact of POAF, reduce postoperative complications, and improve overall surgical outcomes.

Further large-scale, multicenter prospective studies are warranted to validate these findings and to refine predictive models that can guide targeted prophylactic interventions in patients undergoing CABG.

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