Postoperative Atrial Fibrillation Following Isolated Coronary Artery Bypass Grafting: Incidence, Predictors, and Clinical Outcomes

Mehmet Rum[1], Halit Er[2], Fatmagul Yilmaz[3], Levent Ceylan[3] and Bulend Ketenci[3]

[1]*Department of Cardiovascular Surgery, Kosuyolu High Specialisation Education and Research Hospital, University of Health Sciences, Istanbul, Turkiye*

[2]*Department of Cardiovascular Surgery, Kirklareli Training and Research Hospital, Ministry of Health, Kirklareli, Turkiye*

[3]*Department of Cardiovascular Surgery, Dr. Siyami Ersek Thoracic Cardiovascular Surgery Training and Research Hospital, University of Health Sciences, Istanbul, Turkiye*

ABSTRACT

Objective: To investigate the incidence of postoperative atrial fibrillation (POAF) in patients following isolated coronary artery bypass grafting (CABG), evaluate its impact on mortality and morbidity, and analyse demographic and comorbid variables associated with its onset.

Study Design: Observational cohort study.

Place and Duration of the Study: Department of Cardiovascular Surgery, Dr. Siyami Ersek Thoracic Cardiovascular Surgery Training and Research Hospital, University of Health Sciences, Istanbul, Turkiye, from June 2020 to December 2022.

Methodology: Patients who underwent isolated CABG were included in the study. Those diagnosed with valvular heart disease on echocardiography were excluded, as were those with a history of atrial fibrillation (AF).

Results: Statistical analysis was conducted on data from 489 patients. Among the demographic factors examined, only age ($p = 0.021$) exhibited a significant correlation with the development of POAF. Chronic renal disease ($p = 0.044$) and reduced glomerular filtration rate (GFR) levels ($p = 0.020$) were significantly associated with POAF. Regarding perioperative factors, cardiopulmonary bypass (CPB) duration ($p = 0.104$) was not significantly related to POAF, whereas prolonged cross-clamp time was ($p = 0.009$). POAF was associated with postoperative complications, including acute kidney damage ($p = 0.002$), extended intubation ($p = 0.003$), infection ($p < 0.001$), the need for intra-aortic balloon pump (IABP) or inotropic support ($p = 0.004$), and mortality ($p = 0.001$).

Conclusion: POAF is a common complication after isolated CABG and is significantly associated with advanced age, reduced GFR, chronic kidney disease, and prolonged cross-clamp time. Its occurrence is associated with increased postoperative morbidity and mortality. These findings emphasise the importance of perioperative risk factors in predicting adverse outcomes.

Key Words: *Atrial fibrillation, Coronary artery bypass, Acute kidney injury, Mortality, Morbidity, Intra-aortic balloon pumping*.

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INTRODUCTION

Postoperative atrial fibrillation (POAF) is the most common arrhythmia following cardiac surgery, occurring in up to 35% of patients depending on procedure type.[1] Its development not only complicates immediate postoperative care but also increases long-term risks of stroke, heart failure, and all-cause mortality.[2,3] Furthermore, POAF is a major contributor to prolonged hospitalisation and increased healthcare expenditures in the patients population.[4,5]

Correspondence to: Dr. Mehmet Rum, Department of Cardiovascular Surgery, Kosuyolu High Specialisation Education and Research Hospital, University of Health Sciences, Istanbul, Turkiye
E-mail: mehmetrum@gmail.com

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Associations have been found between POAF and increased left atrial diameter, raising concerns about confounding effects due to mitral valve disease.[6] POAF is a common complication following coronary artery bypass grafting (CABG), typically developing within the first three to four postoperative days, with the highest incidence on the second day. Reported incidence rates following isolated CABG range from 13.5-28.4%.[7,8] The pathogenesis of POAF is multifactorial, involving atrial stretch, inflammation, oxidative stress, and autonomic imbalance.[9,10] Several risk factors have been consistently associated with POAF, including advanced age, left atrial enlargement, hypertension, and renal dysfunction.[11]

Identified risk factors include a history of stroke, increased left atrial diameter, and old age.[7,12] During the postoperative period, POAF has been associated with prolonged hospitalisation, extended intensive care unit stays, embolic events, and increased early and late mortality.

Early prediction of POAF is essential to reduce the preventable morbidity and mortality rates, and improve the management strategies. Although many studies have examined POAF following cardiac surgery in general, fewer have specifically focused on isolated CABG, where the exclusion of concomitant valvular surgery offers a clearer view of procedure-specific risk factors.[7,13,14] This study aimed to examine the incidence of POAF in isolated CABG patients, identify associated risk factors, and evaluate its impact on morbidity and mortality. Understanding the incidence and predictors of POAF in this homogenous surgical population may facilitate the identification of high-risk individuals and guide perioperative strategies to improve outcomes.

METHODOLOGY

This retrospective observational cohort study included patients who underwent isolated CABG at the Department of Cardiovascular Surgery, Dr. Siyami Ersek Thoracic Cardiovascular Surgery Training and Research Hospital, University of Health Sciences, Istanbul, Turkiye, from June 2020 to December 2022. The study was approved by the hospital research Ethics Committee of (Approval No: E-28001928-604.01-263766095; Dated: December 26, 2024).

Perioperative full blood count and biochemical data, echocardiographic findings, and demographic information (age, height, weight, and comorbidities) were obtained from the standard hospital records. Intraoperative data, including cross-clamp time, cardiopulmonary bypass (CPB) durations, and postoperative parameters (such as full blood count, biochemical tests, length of hospital stay, and infection records), were analysed.

A total of 498 patients were initially enrolled in the study. Eight patients with preoperative atrial fibrillation (AF) and one patient lacking preoperative electrocardiography records were excluded to avoid bias, yielding a final cohort of 489 patients.

Statistical analyses were performed using IBM SPSS Statistics 27. Continuous variables were expressed as mean ± standard deviation comprised using the Student's t-test, assuming normal distribution based on the central limit theorem (sample size >30). The Chi-square test was employed to analyse categorical variables. Statistical significance was established at $p < 0.05$.

RESULTS

The study population consisted of 18.6% women (n = 91) and 81.4% men (n = 398). Among the patients, 66.9% (n = 327) had diabetes mellitus, 65% (n = 320) had hypertension, 60.7% (n = 297) had hyperlipidaemia, and 41% (n = 200) were smokers.

POAF was observed in 20.2% (n = 99) of patients during hospitalisation, while 79.7% (n = 390) maintained sinus rhythm. Patients with POAF were older (63.13 ± 7.65 years) compared to the control group (60.86 ± 9.00 years), showing a significant difference (p = 0.021). Gender distribution revealed no significant difference, with males comprising 77.8% (n = 77) in the POAF group and 82.3% (n = 321) in the control group (p = 0.301; Table I).

Regarding comorbidities, diabetes was present in 74.7% (n = 74) of the POAF group (p = 0.062), hypertension in 71.7% (n = 71; p = 0.141), hyperlipidaemia in 64.6% (n = 64; p = 0.372), peripheral artery disease in 11.1% (n = 11; p = 0.571), stroke history in 5.1% (n = 5; p = 0.746), and chronic obstructive pulmonary disease in 13.1% (n = 13; p = 0.155). Only chronic kidney disease showed a significant association with POAF (24.2%, p = 0.044; Table I).

Preoperative glomerular filtration rate (GFR) was significantly lower in the POAF group (77.89 ± 20.80) compared to the control group (82.86 ± 18.42, p = 0.020). However, the preoperative creatinine levels were not associated with POAF (0.98 ± 0.49 mg/Dl; 1.11 ± 0.94 mg/dL; p = 0.206). Although CPB duration was not significantly different (116.42 ± 40.36 *vs.* 109.88 ± 34.31 minutes, p = 0.104), cross-clamp time was significantly longer in the POAF group (73.44 ± 27.71 *vs.* 65.97 ± 24.66 minutes, p = 0.009; Table II).

Table I: The relationship between the preoperative variables, demographic data, and POAF.

Parameters	POAF (n = 99)	Non-POAF (n = 390)	p-values
DM (n = 327)	74.4% (n = 74)	64.9% (n = 253)	0.062
HT (n = 320)	71.7% (n = 71)	63.8% (n = 249)	0.141
HL (n = 297)	64.6% (n = 64)	59.7% (n = 233)	0.372
PAD (n = 47)	11.1% (n = 11)	9.2% (n = 36)	0.571
Preoperative CVE (n = 28)	5.1% (n = 5)	5.9% (n = 23)	0.746
Smokers (n = 297)	43.4% (n = 43)	40% (n = 159)	0.631
COPD (n = 46)	13.1% (n = 13)	8.5% (n = 33)	0.155
CKD (n = 85)	24.2% (n = 24)	15.6% (n = 61)	0.044
Gender male (n = 398)	77.8% (n = 77)	82.3% (n = 321)	0.301
Age (years)	63.13 ± 7.65	60.86 ± 9.00	0.021*
Preoperative GFR (mL/min/1.73m^2) (mean)	77.89 ± 20.80	82.86 ± 18.42	0.020*
Preoperative creatinine levels (mg/dL) (mean)	1.11 ± 0.94	0.98 ± 0.49	0.206*
Preoperative Hb (g/dL) (mean)	13.27 ± 1.64	13.39 ± 1.81	0.569*
HbA1c (%) (mean)	8.20 ± 2.04	7.83 ± 2.21	0.161*

**Calculated using the Student t-test; other p-values were calculated using the Chi-square test.*
DM: Diabetes mellitus; HT: Hypertension; HL: Hyperlipidaemia; PAD: Peripheral arterial disease; CVE: Cerebrovascular event; CKD: Chronic kidney disease; GFR: Glomerular filtration rate; Hb: Haemoglobin; HbA1c: Glycosylated haemoglobin; POAF: Postoperative atrial fibrillation; COPD: Chronic obstructive pulmonary disease.

Table II: The relationship between the postoperative variables after isolated CABG and POAF.

Parameters	POAF (n = 99)	Non-POAF (n = 390)	p-values
CPB duration (minutes, mean)	116.42 ± 40.36	109.88 ± 34.31	0.104*
Cross-clamp time (minutes, mean)	73.44 ± 27.71	65.97 ± 24.66	0.009*
IABP/ inotropic requirement	10.1% (n = 10)	2.8% (n = 11)	0.004
Postoperative AKI	7.1% (n = 7)	1.0% (n = 4)	0.002
Dialysis requirement	4.0% (n = 4)	1.5% (n = 6)	0.123
Prolonged intubation	15.2% (n = 15)	6.2% (n = 24)	0.003
Postoperative CVE	9.1% (n = 9)	2.6% (n = 10)	0.006
Infection	36.4% (n = 36)	19.7% (n = 77)	<0.001
Length of hospital stay (days)	10.73 ± 8.24	7.78 ± 6.27	0.001*
Mortality	11.1% (n = 11)	2.6% (n = 10)	0.001

**Calculated using the Student t-test; other p-values were calculated using the Chi-square test.*
IABP: Intra-aortic balloon pump; AKI: Acute kidney injury; CVE: Cerebrovascular event; POAF: Postoperative atrial fibrillation.

POAF was significantly associated with several postoperative complications, including inter-aortic ballon pump (IABP) or high inotropic support: 10.1% (p = 0.004), acute kidney injury (AKI): 7.1% (p = 0.002), prolonged intubation: 15.2% (p = 0.003), postoperative stroke: 9.1% (p = 0.006), infection: 36.4% (p <0.001), and mortality: 11.1% (p = 0.001). The mean hospital stay was significantly longer in the POAF group (10.73 ± 8.24 days) compared to the control group (7.78 ± 6.27 days, p = 0.002). Although dialysis was more frequent in the POAF group (4.0% *vs.* 1.5%), this difference was not statistically significant (p = 0.123; Table II).

DISCUSSION

The findings of this study are consistent with previous research on POAF following isolated CABG, showing similar incidence rates and associated risk factors. A 2014 single-centre study also identified advanced age as a significant predictor of adverse outcomes.[6] In the present cohort, age was likewise significantly associated with POAF, while no difference was observed in preoperative haemoglobin (Hb) levels (p = 0.569). In contrast, a meta-analysis by Seo *et al*. and a large cohort by Maia *et al*. reported an association between low preoperative Hb and POAF.[15,16] This discrepancy may be attributed to the smaller sample size in this study. Additionally, a reduced preoperative GFR was significantly associated with POAF (p = 0.020), supporting previous evidence linking renal dysfunction to increased arrhythmic risk.

The result of the study by Maia *et al*. demonstrated a significant difference regarding smoking status, whereas no significant associations were found for gender, hypertension, diabetes mellitus, hyperlipidaemia, or the presence of peripheral arterial disease. In contrast, the present study did not observe a significant difference in smoking status between the groups (p = 0.631).[16] However, consistent with their findings, this study demonstrated significant differences in the postoperative period concerning the IABP support (p = 0.004), stroke (p = 0.006), infection (p <0.001), postoperative AKI (p = 0.002), prolonged intubation (p = 0.003), and mortality (p = 0.001). Notably, although POAF was associated with postoperative AKI, it did not show a significant association with the need for postoperative dialysis (p = 0.123). This underscores the intricate relationship between POAF and renal complications.

This study also highlighted a significant association between prolonged cross-clamp time, an intraoperative variable, and the development of POAF (p = 0.009) which is in line with previous studies demonstrating that extended cross-clamp duration increases the risk of AF development.[17,18] Extended cross-clamp time may represent a potential risk factor for POAF. The study by Cui *et al*. demonstrated a relationship between prolonged CPB time and AF; however, the findings of the present study did not show a significant association between prolonged CPB time and POAF (p = 0.104).[14] This difference underscores the need for additional research on the influence of intraoperative factors on the onset of POAF.

The results indicate that advanced age and comorbidities, especially chronic kidney disease, significantly elevate the risk of POAF. This is consistent with previous research emphasising the role of impaired renal function in systemic inflammation and atrial remodelling, which increases the risk of arrhythmias in patients.

Previous studies have primarily concentrated on the left atrial diameter as a risk factor for POAF;[19,20] however, this study emphasises the significance of additional perioperative factors, including cross-clamp time. Extended ischaemia during cross-clamping may increase myocardial stress, leading to the development of AF. CPB duration did not exhibit a significant difference, indicating that ischaemia-reperfusion injury associated with cross-clamping may be more critical than the overall duration of the extracorporeal circulation.

This research is subject to inherent limitations due to its retrospective observational design. These limitations include the possibility of selection bias and incomplete data. Although efforts were made to control for confounding factors, the influence of unexamined variables on the outcomes cannot be entirely excluded. Furthermore, the research was conducted at a single centre, potentially limiting the generalisability of the findings.

CONCLUSION

POAF was observed as a common complication following isolated CABG. Significant associations were identified between POAF and advanced age, reduced preoperative

GFR, chronic kidney disease, and prolonged aortic cross-clamp time. While no difference in preoperative Hb levels or CPB time was observed, POAF was significantly associated with adverse postoperative outcomes, including AKI, infection, prolonged intubation, stroke, and increased mortality. Despite its association with renal dysfunction, POAF did not correlate with postoperative dialysis requirement. These findings underscore the relevance of preoperative and intraoperative factors in the development of POAF and its impact on postoperative morbidity and mortality.

ETHICAL APPROVAL:

The study was approved by the Ethics Committee of the Dr. Siyami Ersek Thoracic Cardiovascular Surgery Training and Research Hospital, University of Health Sciences, Istanbul, Turkiye (Approval No. E-28001928-604.01-263766095; Dated: December 26, 2024).

PATIENTS' CONSENT:

Informed consent was obtained from all participants involved in the study.

COMPETING INTEREST:

The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:

MR: Conception, study design, data collection, statistical analysis, interpretation of the results, drafting of the manuscript, and critical revision of the manuscript.
HE: Patient selection, data acquisition, and critical revision of the manuscript.
FY: Data entry, literature review, and manuscript editing.
LC: Statistical analysis and postoperative follow-up assessment.
BK: Supervision and final approval of the manuscript.
All authors approved the final version of the manuscript to be published.

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