
MULTIVESSEL CORONARY ARTERY DISEASE AS A PREDICTOR OF PROLONGED POSTOPERATIVE ATRIAL FIBRILLATION AFTER CARDIAC SURGERY

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Abstract: Postoperative atrial fibrillation (POAF) is the most common arrhythmia following cardiac surgery and is associated with prolonged hospitalization, postoperative complications, and increased healthcare burden. Given the potential role of coronary artery disease (CAD) in atrial ischemia and remodeling, CAD burden may contribute to prolonged arrhythmic episodes.

Aim: To evaluate whether multivessel coronary artery disease is associated with prolonged postoperative atrial fibrillation (>48 hours) in patients undergoing cardiac surgery.

This retrospective study included 378 adult patients with POAF after cardiac surgery at Zan Mitrev Clinic (2020–2023). Only patients with preoperative sinus rhythm and at least one-year follow-up were analyzed. Demographic, clinical, echocardiographic, and angiographic data were extracted from medical records. CAD severity was categorized as one-vessel, two-vessel, or multivessel disease. The duration of postoperative AF was recorded for each patient, allowing comparison of clinical characteristics across different POAF duration patterns. Statistical analysis included Mann–Whitney U test, Chi-square test, and Fisher’s exact test, with $p < 0.05$ considered significant.

Across the cohort, POAF episodes varied from short-lasting to sustained arrhythmia exceeding 48 hours. Of the 378 patients, 193 experienced episodes lasting 48 hours or less, while 185 had POAF that persisted beyond 48 hours. No significant differences were found between groups regarding age, BMI, smoking status, hypertension, diabetes, dyslipidemia, COPD, thyroid disease, renal dysfunction, or preoperative echocardiographic indices (all $p > 0.05$). However, CAD severity differed significantly ($\chi^2 = 8.891$; $p = 0.0308$), with multivessel CAD being more prevalent in patients with prolonged POAF (57.8% vs. 48.2%).

Multivessel CAD is significantly associated with prolonged POAF duration. Incorporating CAD burden into perioperative risk assessment may enhance identification of patients at risk for sustained arrhythmia and guide targeted postoperative monitoring.

Keywords: Atrial fibrillation, Cardiac surgery, Coronary artery disease, Multivessel disease

1. INTRODUCTION

Postoperative atrial fibrillation (POAF) is the most common type of secondary atrial fibrillation, occurring in up to 30–50% of patients after cardiac surgery (Gaudino et al., 2023; Shah et al., 2024). Despite advances in surgical techniques and perioperative care, POAF remains a major clinical challenge due to its association with longer intensive care unit (ICU) stays, prolonged hospitalization, and increased healthcare costs (Qureshi et al., 2021). Moreover, patients who develop POAF have higher risks of postoperative stroke, heart failure, and both short- and long-term mortality (Gaudino et al., 2023; Shah et al., 2024).

The pathogenesis of POAF is multifactorial, involving structural, electrophysiological, inflammatory, and ischemic mechanisms. Surgical stress, systemic inflammation, oxidative stress, and autonomic imbalance contribute to the initiation of transient atrial electrical remodeling (Rezaei et al., 2019). Perioperative ischemia-reperfusion injury and direct atrial manipulation further exacerbate the arrhythmogenic substrate (Mathew et al., 2004). Recently, coronary artery disease (CAD) affecting atrial branches has been proposed as an additional mechanism, as impaired perfusion of the atrial myocardium may increase atrial vulnerability and the likelihood of AF onset (Pokorney et al., 2022).

Multiple studies have identified both clinical and echocardiographic predictors of POAF. Established predisposing factors include advanced age, hypertension, heart failure, chronic obstructive pulmonary disease, and previous myocardial infarction (Yamashita et al., 2018; Seo et al., 2021; Gdey et al., 2024). Echocardiographic markers such as increased left atrial diameter, reduced left ventricular ejection fraction (LVEF), and impaired atrial strain have also been associated with higher risk (Thorén et al., 2012; Perić et al., 2024). However, most previous research has focused on the occurrence of POAF, while much less attention has been given to factors influencing its duration and persistence beyond the early postoperative period.

Importantly, coronary artery disease is not only a marker of systemic atherosclerosis but also a potential driver of atrial ischemia and remodeling. Studies in coronary patients have demonstrated that the burden and distribution of CAD, particularly involving the atrial branches of the right and circumflex arteries, correlate with the likelihood of developing atrial fibrillation (Pokorney et al., 2022). Nevertheless, the relationship between the *extent* of CAD and the *duration* of POAF after cardiac surgery remains underexplored.

Therefore, the present study aimed to investigate whether the presence of multivessel coronary artery disease is associated with prolonged postoperative atrial fibrillation (>48 hours) in patients undergoing cardiac surgery. By examining demographic, clinical, and echocardiographic characteristics, this study seeks to improve risk stratification and identify patients at increased risk of sustained arrhythmic episodes following surgery.

2. MATERIALS AND METHODS

Study Setting and Population

This retrospective study was carried out at Zan Mitrev Clinic (Skopje, North Macedonia) and included adult patients who developed atrial fibrillation after cardiac surgery during the four-year period from January 2020 to December 2023. Only individuals in sinus rhythm preoperatively were considered eligible. Patients with incomplete clinical documentation or insufficient postoperative follow-up (less than one year) were not included in the final analysis.

Data Collection

Clinical information was retrieved from the institutional electronic health record system and complemented by data obtained during routine outpatient follow-up. Extracted variables encompassed demographic characteristics, anthropometric measurements, smoking status, and the presence of common cardiovascular and systemic comorbidities such as arterial hypertension, type 2 diabetes mellitus, dyslipidemia, chronic kidney disease (defined as eGFR ≤ 60 mL/min/1.73 m²), COPD, and thyroid disorders.

Preoperative echocardiographic parameters, including left ventricular ejection fraction (LVEF) and left atrial diameter (LAD), were obtained from standardized transthoracic studies performed at the clinic. All patients underwent a standardized preoperative transthoracic echocardiographic evaluation at our institution. Coronary angiography reports were reviewed to determine both the presence and the anatomical extent of coronary artery disease, which was categorized as single-, double-, or multivessel involvement. Valvular pathology (mitral or aortic) was recorded based on preoperative transthoracic echocardiography.

Assessment of Postoperative Atrial Fibrillation

For all included patients, we documented the onset and overall duration of postoperative AF. Additional perioperative parameters—such as length of hospitalization, method of rhythm control (pharmacologic or electrical), and the prescribed antiarrhythmic or anticoagulation regimen—were extracted in a standardized manner.

Patients were subsequently classified according to POAF duration for analytical purposes; however, this categorization was not used as an inclusion criterion.

Statistical Analysis

Data processing and statistical evaluation were performed using IBM SPSS Statistics, version 26. Continuous variables were examined for normality using the Shapiro–Wilk test and presented as means with standard deviations or medians with interquartile ranges, as appropriate. Group comparisons were conducted using the Mann–Whitney U test for continuous variables and Pearson’s Chi-square or Fisher’s exact test for categorical variables. Statistical significance was defined as $p < 0.05$.

Ethical Considerations

The study received approval from the Ethics Committee of Zan Mitrev Clinic and the Ethics Committee of the University “Goce Delcev” in Stip, and was conducted in accordance with the principles outlined in the Declaration of Helsinki.

3. RESULTS

A total of 378 patients who developed POAF following cardiac surgery were included in the analysis, of whom 268 (70.9%) were male. The duration of POAF ranged from brief, self-limited episodes to sustained arrhythmia

exceeding 48 hours. For analytical purposes, we evaluated clinical and echocardiographic characteristics across the two observed POAF duration patterns (≤ 48 hours and >48 hours).

There were no differences in age (65.67 ± 8.91 vs. 66.47 ± 7.56 years; $p = 0.7004$) or BMI (27.95 ± 4.93 vs. 27.77 ± 4.35 kg/m²; $p = 0.3384$). Comorbidities such as diabetes mellitus (29.0% vs. 36.2%; $p = 0.1352$), dyslipidemia (91.2% vs. 90.8%; $p = 0.8970$), thyroid disease (9.8% vs. 7.6%; $p = 0.4330$), COPD (9.8% vs. 9.7%; $p = 0.9700$), arterial hypertension (96.9% vs. 96.8%; $p = 0.9406$), and impaired renal function (82.9% vs. 82.2%; $p = 0.8499$) were comparable. Smoking status also showed no significant variation between patterns of POAF duration ($p = 0.5518$).

Valvular abnormalities were similarly distributed ($p = 0.6700$). Preoperative echocardiographic measurements, including LVEF ($48.72 \pm 9.33\%$ vs. $47.18 \pm 9.83\%$; $p = 0.1702$) and LAD (39.83 ± 7.46 mm vs. 39.45 ± 6.94 mm; $p = 0.6287$), did not differ between the two POAF duration categories.

However, coronary artery disease severity demonstrated a statistically significant association with longer POAF episodes ($\chi^2 = 8.891$; $p = 0.0308$). Multivessel CAD was more common among patients with prolonged POAF (57.8%) compared with those with shorter episodes (48.2%).

Taken together, the findings suggest that most baseline clinical and structural parameters were similar regardless of POAF duration, whereas the burden of coronary disease appeared to be a key factor associated with sustained arrhythmia.

4. DISCUSSION

Among the 378 adults who experienced postoperative atrial fibrillation after cardiac surgery at our center, a clear pattern emerged linking the burden of coronary artery disease to the duration of the arrhythmia. Patients with longer-lasting POAF (>48 h) more frequently demonstrated multivessel CAD compared with those whose episodes resolved within 48 hours (57.8% vs. 48.2%; $\chi^2 = 8.891$; $p = 0.0308$). Aside from this relationship, demographic factors, major comorbidities, renal function, smoking status, and preoperative echocardiographic findings—including LVEF and left atrial size—showed no meaningful variation between the two POAF duration profiles. This observation underscores the possibility that coronary disease severity, rather than traditional clinical predictors, may play a more prominent role in sustaining postoperative AF episodes.

To compare our findings with previous research, it is important to review prior studies on predictors of POAF occurrence and persistence. Most prior work has emphasized the occurrence of POAF rather than its duration. For example, Auer et al. (prospective, $n = 253$) found that age and valve surgery were independent predictors of POAF, whereas BMI and sex were not (Auer et al., 2005). Large observational cohorts and meta-analyses consistently identify older age, atrial enlargement, lower EF, and procedure type/complexity as key predictors of POAF incidence (Eikelboom et al., 2020; Seo et al., 2021; Yamashita et al., 2018; Thorén et al., 2012). In the prospective CTSN cohort ($n = 2104$), older age, HF, hypothyroidism, and valve or combined procedures (vs isolated CABG) were associated with higher POAF risk (Bowdish et al., 2023). Focused CABG cohorts further highlight LA size/strain and LV strain as echocardiographic predictors (Sabry et al., 2021). More recently, Perić et al. (2024) demonstrated that atrial mechanics—specifically impaired atrial emptying function, prolonged total atrial conduction time (TACT), and reduced LA emptying fraction (LAEF) and conduit strain (LAKE)—are strong independent predictors of POAF, with excellent discriminatory performance (AUC 0.94). These data emphasize that advanced echocardiographic indices related to atrial function are increasingly recognized as superior predictors of POAF compared with conventional measurements such as LAD or LVEF.

These findings are consistent with the broader CABG literature, where systematic reviews and meta-analyses have repeatedly identified age, reduced LVEF, prior MI, IABP use, and prolonged CPB time as key determinants of POAF incidence (Gdey et al., 2024; Yamashita et al., 2018; Dave et al., 2018; Velioglu & Yuksel, 2019; Gorczyca et al., 2017). Against this background, our data add a complementary perspective: while we confirm that many “traditional” predictors do not differentiate patients by duration (≤ 48 h vs >48 h), multivessel CAD does. Reviews synthesize the multifactorial nature of POAF—autonomic imbalance, inflammation/oxidative stress, atrial stretch, ischemic injury—and call out the limited performance of current prediction models (Qureshi et al., 2021; Gaudino et al., 2023; Suero et al., 2024). Our findings align with that view, yet nuance it by linking disease extent in the epicardial coronaries to prolonged arrhythmic episodes, a facet less frequently analyzed explicitly in duration-stratified terms in the cited literature.

The association between multivessel CAD and longer POAF is biologically plausible. Extensive CAD implies a higher ischemic burden and microvascular dysfunction, favoring atrial structural and electrical remodeling that can sustain AF once triggered peri-operatively. More diffuse atherothrombotic disease also often co-travels with longer or more complex procedures, potentially increasing myocardial ischemia-reperfusion injury and inflammatory signaling—all key mechanistic pathways in POAF (Gaudino et al., 2023; Suero et al., 2024). Taken together, our

results emphasize the importance of incorporating coronary disease burden into postoperative risk-stratification models for POAF.

Clinically, patients with multivessel CAD should be recognized as having an increased risk of prolonged POAF. This finding underscores the importance of optimized perioperative management and vigilant postoperative monitoring to prevent sustained arrhythmia and related complications.

Because stroke risk in POAF can be lower than in non-valvular AF and bleeding risk is higher in the early postoperative phase, anticoagulation should be individualized—another point emphasized by contemporary clinical reviews (Suero et al., 2024; Gaudino et al., 2023).

Limitations and future directions

Our study is retrospective and single-center, limiting causal inference and generalizability. We did not capture granular intra-operative variables (CPB/cross-clamp times, completeness/quality of revascularization) or detailed perioperative inflammatory/electrolyte trajectories, all known correlates of POAF. While we focused on duration (>48 h), we did not evaluate long-term AF recurrence, thromboembolism, or mortality by duration strata—outcomes of high clinical salience (Eikelboom et al., 2020). Future prospective multicenter studies should incorporate angiographic scoring, echocardiographic deformation imaging (e.g., LA/LV strain), and standardized rhythm monitoring to quantify AF burden and test whether CAD-extent-guided prophylaxis meaningfully shortens POAF duration and improves clinical endpoints.

5. CONCLUSION

In this retrospective cohort of cardiac surgery patients with postoperative atrial fibrillation, we identified a significant association between the extent of coronary artery disease and the duration of POAF. While traditional risk factors such as age, hypertension, diabetes, and echocardiographic parameters (LVEF, LAD) were comparable between groups, multivessel CAD emerged as a potential determinant of prolonged POAF episodes.

These findings highlight the importance of assessing coronary disease burden in postoperative arrhythmia risk stratification. Patients with multivessel CAD may benefit from closer rhythm monitoring and individualized preventive strategies during the perioperative period. Further prospective studies are warranted to confirm the mechanistic link between ischemic burden, atrial remodeling, and POAF persistence, and to determine whether targeted interventions could shorten arrhythmic duration and improve outcomes.

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