Research Article

Interventional Cardiology

Risk factors and clinical impact of new-onset atrial fibrillation following cardiac surgery: A single-centre prospective study in Yemen

Abstract

Background: New-onset Postoperative Atrial Fibrillation (POAF) is a common arrhythmic complication after cardiac surgery, associated with increased morbidity, prolonged hospital stays, and elevated resource utilization. We conducted this study to identify preoperative, intraoperative, and postoperative risk factors associated with POAF and to assess its clinical outcomes among patients undergoing cardiac surgery.

Methods: We conducted a prospective observational study on 210 consecutive adult patients who underwent cardiac surgery at our tertiary center in Yemen. Patients were grouped into POAF (n=32, 15.2%) and non-POAF (n=178, 84.8%) cohorts. Multivariable logistic regression was used to identify independent risk factors.

Results: POAF occurred in 32 patients (15.2%). Posterior pericardiotomy was found to be a significant protective factor against POAF (OR=0.388, 95% CI: 0.184-0.820, p=0.013). No significant differences were observed in age, gender, or baseline comorbidities between groups. However, POAF was significantly associated with adverse postoperative outcomes, including longer ICU stay (27.0 vs 24.0 hours, p=0.036), higher rates of pericardial effusion (75.0% vs 15.2%, p<0.001), cardiac tamponade (15.6% vs 2.8%, p=0.002), pulmonary complications (18.8% vs 5.1%, p=0.006), and renal impairment (18.8% vs 6.7%, p=0.025). Additionally, POAF was associated with significantly increased risk of re-exploration (12.5% vs 2.2%, p=0.005), postoperative stroke (9.4% vs 1.1%, p=0.001), congestive heart failure (12.5% vs 2.2%, p = 0.005), and overall adverse events (18.8% vs 2.2%, p=0.001). Hospital mortality was also notably higher in the POAF group (9.4% vs 1.1%, p=0.001), and median hospital stay was prolonged (7.0 vs 6.0 days, p=0.001).

Conclusion: New-onset POAF following cardiac surgery is associated with a significantly increased risk of life-threatening complications and in-hospital mortality.

Keywords: Postoperative atrial fibrillation • Cardiac surgery • Risk factors • Stroke • Mortality • Complications

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Introduction

Atrial Fibrillation (AF) is the most frequent arrhythmic complication encountered following cardiac surgery, with an incidence ranging between 10% and 65%, depending on the type of procedure, patient comorbidities, and perioperative factors [1]. The majority POAF episodes are transient; approximately 15%-30% of cases revert spontaneously to sinus rhythm within the first two hours, and up to 80% achieve rhythm normalization within 24 hours following correction of underlying electrolyte imbalances and optimization of hemodynamic status [2]. Despite its transient nature in many patients, POAF is associated with substantial clinical and economic burdens [3-5]. It increases the risk of multiple adverse outcomes, including acute kidney injury, stroke, heart failure exacerbation, hemodynamic instability, prolonged mechanical ventilation, and elevated in-hospital and late mortality [6,7]. Furthermore, POAF contributes significantly to healthcare resource utilization by extending ICU and hospital length of stay and escalating the overall cost of surgical care, particularly in procedures such as Coronary Artery Bypass Grafting (CABG) [8,9].Therefore, identifying modifiable risk factors and implementing effective preventive strategies for POAF remain essential priorities in contemporary cardiac surgical practice. Despite extensive studies, its precise pathophysiology remains unclear, involving a complex interplay of preoperative, intraoperative, and postoperative factors [10].

In resource-limited settings like Yemen, data on POAF remain sparse. This study aims to evaluate the incidence, risk factors, and clinical impact of POAF in a single-center cohort of Yemeni patients undergoing cardiac surgery.

Materials and Methods

Study Design and Population

A prospective observational study was conducted at our cardiovascular surgery unit in Cardiovascular and Kidney Transplant centre in Taizz, Yemen between 1st January 2022 to 30th January 2024. Inclusion criteria were adult patients (>18 years) undergoing elective or urgent cardiac surgery (CABG, valve, or combined procedures). Exclusion criteria included preoperative atrial fibrillation or incomplete data, left-sided pleural adhesions, hyperthyroidism, renal failure with a plasma creatinine level of >2.0 mg/dl), off-pump heart bypass surgery, and patient's refusal to join the study. Patients undergoing mitral or tricuspid valve surgery were excluded. This exclusion was based on the distinct pathophysiology and risk factors for POAF in these patients, which differ from those in patients undergoing other types of cardiac surgery, potentially leading to a heterogeneous population [11,12]. Each patient has informed consent; the study was performed considering the Helsinki Declaration and was approved by the Cardiovascular and kidney transplantation centre Research Ethics Committee.

Data collection

Preoperative, intraoperative (Table 1), and postoperative variables (Table 2), were collected prospectively.

In the postoperative period, the patients were monitored continuously via electrocardiography during the first 3 days after the operation. Continuous monitoring was subsequently reinstituted whenever an arrhythmia was suspected, if there are any changes in the heart rate or when the patient complained of palpitation. The primary outcomes were POAF. It was defined by the following findings: (1) "absolutely" irregular R-R intervals (in the absence of complete atrioventricular block); (2) no distinct P waves on the surface ECG; [13] and (3) any postoperative new-onset AF [14]. Potassium and magnesium supplements were given as necessary to maintain electrolyte balance within the normal range (serum potassium level was corrected if less than 4.5 mmol/l and serum magnesium level was corrected if less than 1.0 mmol/l).

Table 1: Perioperative Risk factors for POAF after cardiac surgery with Univariate analysis.

Variable	Overall (n=210)	POAF group (n=32) 15.2%	Non-POAF group (n=178) 84.8%	Odd Ratio	95% Confidence interval	P-Value
Age, years Mean ± SD	56.89 ± 11.44	58.56 ± 12.01	56.58 ± 11.34	1.005	0.984-1.026	0.626
Gender (Female)	45 (21.5%)	5 (15.6%)	40 (22.5%)	1.051	0.560-1.973	0.877
Hypertension	106 (50.5%)	13 (40.6%)	93 (52.2%)	1.554	0.788-3.065	0.204
Diabetes Mellitus	86 (42.4%)	13 (40.6%)	76(42.7%)	1.064	0.536-2.113	0.859
Smoker	61 (29%)	6 (18.8%)	55 (30.9%)	1.512	0.674-3.388	0.316
Previous MI	153(72.9%)	27 (84.4%)	126 (70.8%)	0.672	0.365-1.237	0.201
Previous stroke / TIA	13 (6.2%)	1 (3.1%)	12 (6.7%)	5.952	0.793-44.650	0.083
COPD	13 (6.2%)	3 (9.4%)	10 (5.6%)	0.634	0.201-1.998	0.437
CHF (NYHA II)	89 (42.4%)	13 (40.6%)	76 (42.7%)	1.072	0.583-1.972	0.824
left atrium size, cm	4 (3.2-4.2)	3.6 (3.4-4.1)	4 (3.5-4.2)	0.996	0.763-1.300	0.974
Preoperative hematocrit, %	38.9 (35.4- 40.8)	39.0 (34.8-40.0)	38.7 (35.7-41.0)	0.955	0.980-1.024	0.198
Preoperative Creatinine	1.0 (0.1-1.1)	1.0 (0.8-1.2)	0.93(0.9-1.2)	0.813	0.294-2.251	0.691
Left ventricular ejection fraction, %	51 (43-60)	50 (40.3-59.7)	52 (45-60)	1.003	0.974-1.032	0.84

Surgical type[a]						
CABG	175(83.3%)	27 (84.4%)	148 (83.1%)			
Aortic valve/ Ascending Aorta procedures	18 (41.8)	4 (12.5%)	14 (7.9%)	0.838	0.495-1.416	0.508
Commination (CABG+Aortic) procedure	17 (5.2%)	1 (3.1)	16 (9.0%)			
Number of grafts Mean ± SD	3.23 ± 0.71	3.25 ± 0.75	3.23 ± 0.71	1.067	0.605-1.882	0.824
Posterior Pericardiotomy	106 (50.4%)	9 (28.1%)	97 (54.5%)	0.477	0.253-0.899	0.022
Cross-clamp time, min	68 (55- 85)	69 (55-86)	67 (55-85)	0.997	0.98-1.007	0.578
Cardiopulmonary bypass time, min	100 (89-123)	100 (90- 120)	100(89-123)	0.997	0.990-1.005	0.5
Operation duration, min	180(160-210)	180 (165-223)	180 (89-210)	1	0.993-1.006	0.904

Note: Data are n (%) or median (IQR). COPD (Chronic Obstructive Pulmonary Disease); (CHF): Chronic Heart Failure; (NYHA): New York Heart Association class; (MI): Myocardial Infarction; (TIA): Transient Ischemic Attack; a Baseline group isolated (CABG): Coronary Arterial Bypass Graft.

Table 2: Compare the Outcome between Patients with POAF and without in Our Study, n = 210.

The outcome variable	Overall (n=210)	POAF group (n=32) 15.2%	Non-POAF group (n=178) 84.8%	P-Value
Total Ventilation time/ hr	3 (3.0-4.5)	3.0 (3.0-4.7)	3.0 (3.0-4.5)	0.994
Total ICU time / hr	24.0 (22.0-29.0)	27.0 (23.0-47.7)	24.0 (22.0-27.0)	0.036
Chest Drain ICU/ml	445 (330-600)	450 (340-650)	430 (310- 552)	0.013
Total Chest Drain	670 (500-880)	670 (500-870)	770 (562-1015)	0.063
Pericardial effusion	51 (24.3%)	24 (75%)	27 (15.2%)	0
Early Pericardial effusion	49 (23.3%)	24 (75%)	25 (14%)	0
Late Pericardial effusion	20 (9.5%)	6 (18.8%)	14 (7.9%)	0.053
Cardiac Tamponade	10 (4.8%)	5 (15.6%)	5 (2.8%)	0.002
Pleural effusion	56 (26.7%)	12 (37.5%)	44 (24.7%)	0.132
left pleural effusion	47 (23%)	10 (31.3%)	37 (20.8%)	0.191
Re-exploration	8 (3.8%)	4 (12.5%)	4 (2.2%)	0.005
Re-exploration for bleeding	2 (1.0%)	1 (3.1%)	1 (0.6)	0.167
Re-exploration for Tamponade	6 (2.9%)	3 (9.4%)	3 (1.7%)	0.016
Hospital stays, days	6.0 (5.0-7.0)	7.0 (6.0-9.0)	6.0 (5.0-7.0)	0.001
Hospital Readmission	23 (11%)	6 (18.8%)	17 (9.6%)	0.125
Hospital mortality	5 (2.4%)	3 (9.4%)	2 (1.1%)	0.001
Postoperative Adverse event	10 (4.8%)	6 (18.8%)	4 (2.2%)	0.001
Congestive heart Failure	8 (3.8%)	4 (12.5%)	4 (2.2%)	0.005
Postoperative Stroke	5 (2.4%)	3 (9.4%)	2 (1.1%)	0.001
Postoperative Pulmonary Complication	15 (7.1%)	6 (18.8%)	9 (5.1%)	0.006
Sternal Complication	13 (6.2%)	3 (9.4%)	10 (5.6%)	0.417
Postoperative Renal impairment	18 (8.6%)	6 (18.8%)	12 (6.7%)	0.025

Note: Significant associations are highlighted, Data are n (%) or median (IQR), Instance Care Unites;(ICU)

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics version 24.0. Descriptive statistics were initially conducted, with categorical variables presented as frequencies, percentages, while continuous variables were summarized as means and Standard Deviations (SD). The differences between the control and intervention groups were assessed using univariate analysis. Continuous variables were analyzed using either the student t test or the Mann-Whitney U test, depending on the data distribution. Categorical variables were evaluated using the chi-squared test, with corresponding 95% Confidence Intervals (CI). A p-value of <0.05 was considered statistically significant. The identified independent predictors of POAF were adjusted in logistic, linear and ordinal regression analysis with Odds ratio, 95% CI and P<0.05.

Results

During the two-half-year study period from 1st January 2022 to 30th June 2024, 210 patients who underwent surgery on the coronary arteries, aortic valve, ascending aorta, or a combination of these procedures. These 210 patients were classified into two groups based on the presence of POAF: the POAF group (n=32, 15.2%) and the non-POAF group (n=178, 84.8%). Table 1 shows the baseline patient characteristics and preoperative and intra operative risk factor for POAF.

The mean age was comparable between the POAF and non-POAF groups (58.56 ± 12.01 vs. 56.58 ± 11.34 years, p=0.521), and no significant gender disparity was noted (male: 84.4% vs 77.5%, p=0.385). Similarly, the prevalence of major comorbid conditions such as hypertension (40.6% vs 52.2%, p=0.226), diabetes mellitus (40.6% vs 42.7%, p=0.981), COPD (9.4% vs 5.6%, p=0.417), congestive heart failure classified as NYHA class II (40.6% vs 42.7%, p=0.827), and renal impairment (3.1% vs 3.4%, p=0.943) did not differ significantly between the two groups. Although prior myocardial infarction was more frequently observed among patients who developed POAF (84.4% vs. 70.8%), the difference did not reach statistical significance (p=0.112).

Intraoperative factors also appeared largely comparable between the groups. The distribution of surgical procedures whether CABG, valve surgery, or combined interventions showed no significant association with POAF development (p=0.508). Additionally, median cross-clamp time (69 vs 67 minutes, p=0.581), cardiopulmonary bypass duration (100 minutes in both groups, p=0.982), and the mean number of bypass grafts (3.25 ± 0.75 vs. 3.23 ± 0.71, p = 0.748) were not significantly different. However, a noteworthy finding was the significantly lower frequency of posterior pericardiotomy in the POAF group (28.1% vs 54.5%, p=0.022).

Patients who developed POAF experienced significantly more adverse outcomes compared to those who maintained sinus rhythm. Notably, POAF was associated with a prolonged ICU stay (median 27.0 vs 24.0 hours, p=0.036). The incidence of pericardial effusion was markedly higher in the POAF group (75.0% vs 15.2%, p<0.001), with a corresponding rise in clinically significant cardiac tamponade events (15.6% vs 2.8%, p=0.002). Additionally, the rate of surgical re-exploration, primarily for tamponade or bleeding, was significantly elevated in the POAF group (12.5% vs 2.2%, p=0.005).

Regard postoperative complication as pulmonary complications occurred more frequently among POAF patients (18.8% vs 5.1%, p=0.006), postoperative renal impairment was also more prevalent in these patients (18.8% vs 6.7%, p=0.025). Additionally, the development or exacerbation of Congestive Heart Failure (CHF) postoperatively was significantly more common in patients with POAF (12.5% vs 2.2%, p=0.005),

POAF was associated with longer total hospital stays (median 7.0 vs 6.0 days, p=0.001). Hospital mortality was significantly elevated in the POAF group, occurring in 9.4% of patients compared to just 1.1% in the non-POAF cohort (p=0.001). Postoperative stroke, observed in 9.4% of POAF patients versus 1.1% in non-POAF patients (p=0.001). Likewise, overall postoperative adverse events were more frequently reported in the POAF group (18.8% vs 2.2%, p=0.001).

Multivariable logistic regression was performed to identify independent predictors of POAF after adjusting for potential confounders. Among the variables included in the model age, gender, hypertension, diabetes mellitus, smoking status, history of myocardial infarction, left atrial size, left ventricular ejection fraction, renal function, surgical priority, and operative characteristics posterior pericardiotomy emerged as the only statistically significant independent protective factor against the development of POAF. Patients who underwent posterior pericardiotomy had a significantly lower risk of POAF (OR=0.388, 95% CI: 0.184-0.820, p=0.013), suggesting a robust protective association (Table 3).

Table 3: Multivariable analysis OF Risk factors for POAF after cardiac surgery.

Variable	Odd Ratio	95% Confidence interval	P-Value
Age, years	1.033	0.982-1.087	0.21
Gender (Female)	0.426	0.118-1.534	0.192
Hypertension	1.945	0.697-5.427	0.204
Diabetes Mellitus	0.811	0.289-2.279	0.691
Smoker (current/ recently)	1.854	0.642-5.354	0.254

Previous myocardial infarction	3.763	0.926-15.289	0.64
left atrium size, cm	0.973	0.667-1.419	0.887
Preoperative hematocrit, %	0.96	0.892-1.033	0.273
Preoperative Creatinine	0.825	0.244-2.785	0.756
Left ventricular ejection fraction, %	1.014	0.980-1.048	0.429
Priority (schedule) of Surgery	0.775	0.303-1.982	0.594
Surgery type[a]			
Valve procedures	2.257	0.475-10.713	0.306
Commination /Other procedure	0.639	0.068-6.039	0.696
Posterior pericardiotomy	0.388	0.184-0.820	0.013
Cross-clamp time, min	1.003	0.981-1.026	0.784
Cardiopulmonary bypass time, min	0.985	0.960-1.010	0.231
Operation duration, min	1.01	0.994-1.026	0.434
Note: Data are n (%) or median (IQR), a Baseline group isolated CABG,			

Discussion

POAF is recognized as the most common arrhythmic complication following cardiac surgery, with an incidence ranging from 19% to 30% according to contemporary surgical literature [15-16]. The onset of POAF typically occurs within the first 48 hours after surgery, coinciding with the peak period of physiological stress and inflammatory response; thereafter, the risk progressively declines over the subsequent 4 to 7 days [17]. This transient but clinically significant arrhythmia has been independently associated with an elevated risk of numerous postoperative complications, including neurologic impairment such as cognitive dysfunction, thromboembolic events like stroke, renal insufficiency, and infectious complications [18].

In a meta-analysis investigating POAF following cardiac surgery, several preoperative risk factors were identified as independent predictors of POAF, including a history of congestive heart failure (P<.001), hypertension (P<.001), advanced age (P<.001), prior stroke or transient ischemic attack (P<.001), and peripheral vascular disease (P<.001) [19]. In contrast, our analysis did not reveal any statistically significant differences in these or other key preoperative demographic and clinical variables between patients who developed POAF and those who did not. Furthermore, intraoperative parameters including cardiopulmonary bypass duration, aortic cross-clamp time, and the number of grafts performed were also not significantly associated with the incidence of POAF in our cohort. This discrepancy may be attributed to several factors, including limited sample size, variations in patient selection, uniform perioperative management protocols, or reduced variability in baseline characteristics, which may have diminished the statistical power to detect meaningful associations. Additionally, the protective effect of posterior pericardiotomy in our study cohort may have mitigated the impact of conventional risk factors, thereby further obscuring their predictive value. These considerations highlight the complexity of POAF pathogenesis and underscore the need for larger, multicenter studies to clarify the relative contributions of individual risk factors.

Our findings demonstrated that patients undergoing posterior pericardiotomy experienced a significantly reduced risk of POAF (OR=0.388; 95% CI: 0.184-0.820; p=0.013), indicating a strong protective effect. These results align with a recent comprehensive meta-analysis by Abdelaziz et al., which included 25 trials and 4,467 patients [20]. Among 22 studies reporting POAF outcomes (n=4,300), the incidence of POAF was markedly lower in the posterior pericardiotomy group (11.7%) compared to controls (23.67%), with a pooled OR of 0.49 (95% CI: 0.38-0.61; p<0.001). This reinforces the effectiveness of posterior pericardiotomy in mitigating POAF, potentially through the reduction of pericardial effusion and mechanical irritation of the left atrium. Collectively, these findings underscore the critical role of targeted intraoperative interventions in optimizing postoperative rhythm outcomes.

POAF remains a significant complication following cardiac surgery, contributing to increased morbidity, mortality, and healthcare utilization [21-23]. In our study, POAF was associated with a wide array of adverse clinical outcomes, including prolonged ICU stay, increased incidence of pericardial effusion, cardiac tamponade, and higher rates of re-exploration for bleeding or tamponade. These findings are strongly corroborated by the meta-analysis by Woldendorp et al., which demonstrated that POAF was significantly associated with major bleeding (OR: 1.49; 95% CI: 1.33-1.66; p<0.001), return to theater (OR: 1.58; 95% CI: 1.38-1.80; p<0.001), and pericardial complications, potentially driven by local inflammation or surgical trauma.

Pulmonary and renal complications were also significantly more common among POAF patients in our Patients. The meta-analysis similarly highlighted acute kidney injury (OR: 2.72; 95% CI: 2.41-3.06; p<0.001) and prolonged ventilation (OR: 2.54; 95% CI: 1.97-3.27; p<0.001) as significantly associated with POAF. These complications may be both a consequence and contributor to POAF via mechanisms such as systemic inflammation, fluid overload, and impaired tissue perfusion.

Additionally, we found that POAF was associated with a higher incidence of postoperative congestive heart failure exacerbation (12.5% vs 2.2%, p=0.005). This aligns with evidence indicating that POAF can precipitate or worsen heart failure through tachycardia-induced cardiomyopathy and loss of atrioventricular synchrony.

Hospital resource utilization was also impacted. In our study, POAF patients had significantly longer hospital stays. Woldendorp et al., reported a mean increase in overall hospital stay by 2.8 days and ICU stay by 0.8 days in POAF patients compared to those in sinus rhythm. These findings underscore the economic burden of POAF alongside its clinical consequences.

Crucially, POAF was significantly associated with increased early and late mortality and stroke. (3,24,25) Our observed in-hospital mortality (9.4% vs 1.1%, p=0.001) and stroke (9.4% vs 1.1%, p=0.001) rates are mirrored in the meta-analysis, which reported early mortality of 7.5% vs 3.6% (OR: 1.74, p<0.001), early stroke of 3.2% vs 1.3% (OR: 2.29, p<0.001), and sustained long-term increases in both stroke (4.0% vs 2.1%) and mortality (18.6% vs 13.3%) after a median follow-up of 6.6 years.

These associations may reflect not only the direct arrhythmogenic effects of POAF but also its interplay with underlying comorbidities and systemic inflammation. Additionally, treatment-related complications, such as bleeding due to anticoagulation or toxicity from antiarrhythmic therapy, further contribute to adverse outcomes. Given the strong and consistent evidence linking POAF to poor outcomes, both in our cohort and the broader literature, targeted preventive strategies such as posterior pericardiotomy as demonstrated in our study and early rhythm control should be considered vital components of perioperative care pathways. These findings highlight the necessity for vigilant monitoring, early identification, and aggressive management of POAF to mitigate its considerable impact on patient outcomes following cardiac surgery.

Limitations

This study has several limitations. Its observational, single-center design limits causal inference and generalizability. The POAF detection may have missed brief asymptomatic episodes. Additionally, potential confounding variables—such as surgeon technique and inflammatory markers were not fully accounted. These factors highlight the need for larger, multicenter prospective studies to validate the findings.

Conclusion

New-onset POAF following cardiac surgery is associated with a significantly increased risk of life-threatening complications and in-hospital mortality. Early identification and targeted perioperative management strategies are essential to mitigate the adverse impact of POAF. Our findings support the routine consideration of posterior pericardiotomy, particularly in patients at elevated risk for POAF.

Ethics approval

This study was approved by the Ethics Committee of Cardiovascular and kidney transplantation centre, Taiz University. This research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki.

EInformed Consent

All participants provided written informed consent prior to enrolment in the study.

Conflict of interest

All authors have no disclosures to report or conflict of interest.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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