The Heart Surgery Forum

Heart Surg. Forum **2025**; 28(12): 49376
https://doi.org/10.31083/HSF49376

Article

Posterior Pericardiotomy in Cardiac Surgery: A Randomized Trial on Postoperative Atrial Fibrillation Prevention in a Yemeni Population

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Academic Editor: Nicholas R. Teman
Submitted: 17 July 2025 Revised: 16 September 2025 Accepted: 23 October 2025 Published: 23 December 2025

Abstract

Background: Atrial fibrillation (AF) is a common complication following cardiac surgery, particularly in populations undergoing complex cardiac procedures. This randomized clinical trial aimed to evaluate the effectiveness of posterior pericardiotomy (PP) in preventing postoperative atrial fibrillation (POAF) in a Yemeni cardiac surgical population. **Methods**: This prospective, single-center, randomized clinical trial conducted in Yemen enrolled 210 patients undergoing open-heart surgery involving coronary artery bypass grafting (CABG), aortic valve replacement, ascending aortic surgery, or a combination of these procedures. Patients were randomized using sealed opaque envelopes into either the PP group (n = 106), in which a posterior left pericardiotomy was performed, or the control group (n = 104), which received standard care without pericardiotomy. **Results**: A total of 436 patients were screened between January 1, 2022, and June 30, 2024, and 210 were randomized. The median age was 60 years (interquartile range (IQR) 50–65), with 165 males (78.5%) and 45 females (21.5%). The incidence of POAF was significantly lower in the PP group compared to the control group (8.5% vs. 22.1%; $p = 0.006$). Cardiac tamponade occurred exclusively in the control group (n = 10). The PP group also demonstrated significantly shorter mechanical ventilation time ($p < 0.001$) and intensive care unit (ICU) stay ($p = 0.004$). In-hospital mortality was significantly lower in the PP group compared to the control group ($p = 0.067$). **Conclusion**: Our findings reinforce the evidence supporting PP as a simple, low-cost adjunct to cardiac surgery. Thus, PP may improve postoperative recovery and resource utilization by reducing POAF, pericardial effusion, and tamponade, particularly in resource-limited settings such as Yemen. **Clinical Trial Registration**: NCT07266935, https://clinicaltrials.gov/study/NCT07266935.

Keywords: posterior pericardiotomy; postoperative atrial fibrillation; cardiac surgery; cardiac tamponade; randomized controlled trial; Yemen

1. Introduction

Postoperative atrial fibrillation (POAF) is one of the most frequent arrhythmic complications following cardiac surgery, with an incidence ranging from 30% to 40% depending on procedure type and assessment methodology [1]. POAF has been associated with both early and late adverse outcomes, including increased mortality, heightened risk of stroke, prolonged hospitalization, and elevated healthcare costs [2,3].

Pericardial effusion, particularly of small to moderate volume, is another common postoperative finding [4]. Echocardiographic studies have demonstrated its occurrence in more than two-thirds of patients after cardiac surgery [4,5]. In this context, posterior pericardiotomy (PP) represents a simple yet effective surgical technique. By creating a communication between the posterior pericardial sac and the left pleural space, PP facilitates continuous drainage of pericardial fluid and thrombi during the early postoperative period [6].

Several studies have investigated the association between PP and POAF incidence, with some reporting significant reductions in POAF, while others showed inconsistent findings [7–9]. Nevertheless, multiple randomized controlled trials (RCTs) and recent meta-analyses have confirmed a statistically significant decrease in POAF incidence among patients undergoing PP [10–12].

Despite its documented benefits and favourable safety profile, PP remains underutilized in routine cardiac surgical practice. To address this gap and provide further evidence, we conducted a randomized controlled trial assessing the efficacy of PP in reducing POAF among patients undergoing coronary artery bypass grafting (CABG), aortic valve replacement (AVR), ascending aortic surgery, or a combination of these procedures. This study also represents the first randomized trial addressing this topic within a Yemeni cardiac surgical population.

2. Patients and Methods

2.1 Study Design and Setting

This prospective, single-center, randomized controlled trial was conducted in the Department of Cardiovascular Surgery, Cardiovascular and Kidney Transplantation Center, Taiz, Yemen, between January 2022 and June 2024.

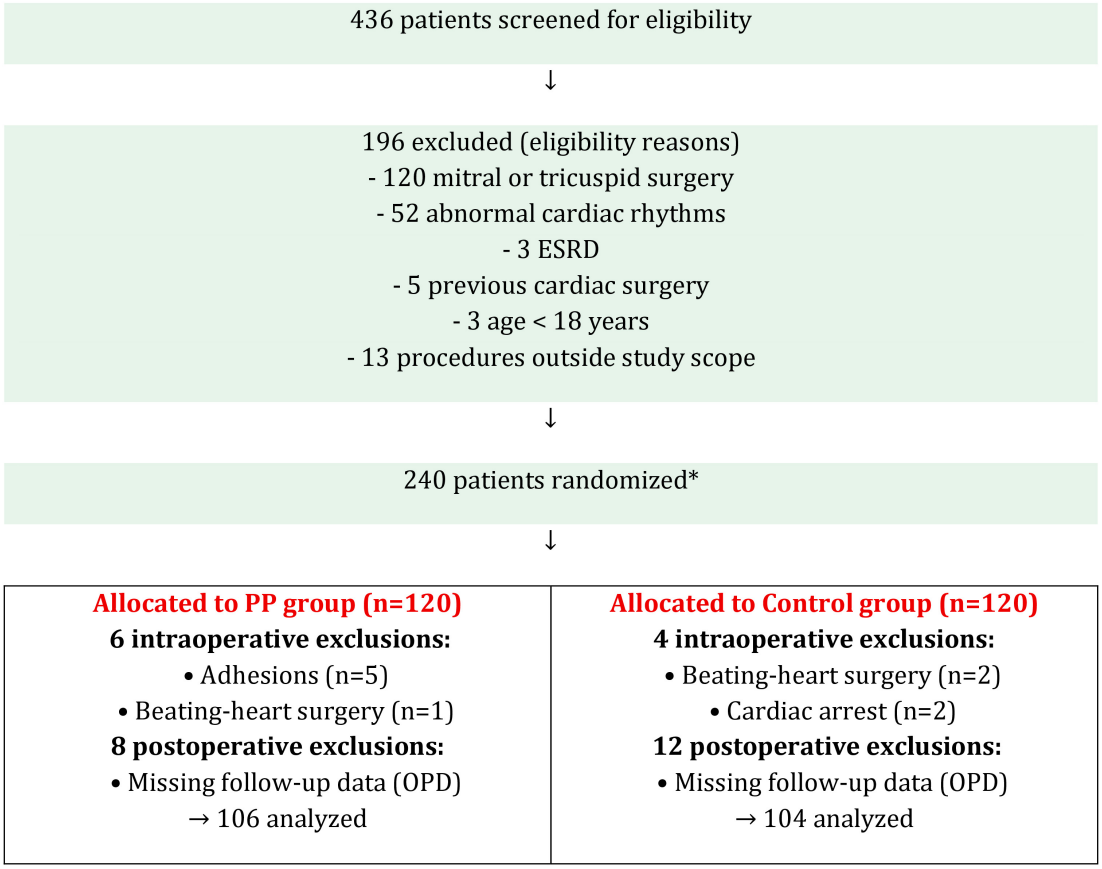

Fig. 1. Trial CONSORT flow diagram. PP, Posterior pericardiotomy; OPD, outpatient clinic; POD, postoperative day. *Randomization: sealed, opaque envelopes prepared by an independent assistant not involved in patient care.

2.2 Ethical Considerations

The study followed the principles of the Declaration of Helsinki. Approval was obtained from the ethical approval was obtained from the Research Ethics Committee of the Cardiovascular and Kidney Transplantation Centre, Taiz University, Yemen (Approval ID 0030425, dated December 20, 2021), and written informed consent was collected from all participants prior to enrollment. The trial is registered with ClinicalTrials.gov (Identifier: NCT07266935).

2.3 Inclusion and Exclusion Criteria

Patients aged $\geq$18 years undergoing elective open-heart surgery (CABG, aortic valve replacement, ascending aortic surgery, or combined procedures) were eligible.

Exclusion criteria included: (1) previous cardiac or thoracic surgery, (2) left-sided pleural adhesions, (3) preoperative atrial fibrillation or other rhythm disorders, (4) hyperthyroidism, (5) renal failure with plasma creatinine $>$2.0 mg/dL, (6) off-pump CABG, (7) mitral or tricuspid valve surgery (excluded due to distinct pathophysiology and POAF risk [1,13]), and (8) refusal to participate.

2.4 Randomization and Blinding

Patients were randomized in a 1:1 ratio to the PP group or the control group using sealed, opaque envelopes prepared by an independent staff member not involved in clinical care. A total of 106 patients were assigned to the PP group, and 104 patients to the control group (Fig. 1).

The trial followed a single-blind design: investigators responsible for data collection and outcome assessment were blinded to group allocation throughout the perioperative and postoperative periods.

2.5 Procedure Detail

All procedures were carried out through a median sternotomy. Prior to initiation of cardiopulmonary bypass (CPB), patients were anticoagulated with intravenous heparin (3 mg/kg) to achieve an activated clotting time (ACT) $>$480 seconds. CPB was managed with moderate hemodilution (hematocrit 20–26%) and systemic hypothermia (28–32 °C), using a roller pump (2.0–2.4 L/m^2/min) and a membrane oxygenator. Mean arterial pressure was maintained between 50–70 mmHg. Myocardial protection was achieved with antegrade infusion of cold blood cardioplegia via the aortic root. At the conclusion of CPB, anticoagulation was reversed with protamine sulfate (3.5 mg/kg).

PP was performed according to the operative procedure. In CABG, it was created after completion of distal vein grafts but before the internal mammary artery–LAD anastomosis. In valve or combined surgeries, PP was car-

ried out after valve excision. The incision measured 4–5 cm, oriented longitudinally and positioned parallel and posterior to the left phrenic nerve, extending from the left inferior pulmonary vein to the diaphragm [11,14]. Any complications during the procedure were recorded.

Chest drainage was standardized in all patients. A 28 Fr tube was inserted into the left pleural cavity and a 32 Fr tube into the anterior mediastinum. The pleural tube was introduced through a separate pleural opening and directed to the lower pleural space. If the right pleura was inadvertently opened, the mediastinal drain was passed through it before being positioned retrosternal. In all cases, the anterior pericardium was left open, and posterior placement of tubes near the heart was avoided to minimize arrhythmic risk.

2.6 Post Operative Outcome

After surgery, patients were transferred to the intensive care unit (ICU). Chest drains were regularly milked and stripped to maintain patency, with low-intermittent suction (–20 cmH_2O) applied. Drainage was measured hourly, and tubes were removed on the second postoperative day once output had fallen below 100 mL in 24 hours. Standard prophylaxis with β-blockers was administered to all patients.

Cardiac rhythm was continuously monitored by electrocardiography for the first three postoperative days. Monitoring was resumed whenever arrhythmia was suspected, when heart rate changes were observed, or if patients experienced palpitations. Electrolytes were corrected as needed, with potassium maintained above 4.5 mmol/L and magnesium above 1.0 mmol/L. Two-dimensional echocardiography was performed on days 3 and 5, before discharge, and again during follow-up to evaluate pericardial effusion. An effusion >1 cm was considered clinically significant. Additionally, echocardiographic examinations were also performed after discharge to detect late effusions and tamponade.

2.7 Study Endpoints

• Primary endpoint: occurrence of POAF was defined as atrial fibrillation documented by a 12-lead electrocardiogram or continuous telemetry monitoring, lasting more than 30 seconds, and occurring after cardiac surgery in patients with no prior history of atrial fibrillation [15,16].

• Secondary endpoints: requirement for antiarrhythmic medications, systemic anticoagulation, or cardioversion; development of pericardial or pleural effusion, cardiac tamponade, or need for reexploration; duration of ventilation (hours under mechanical ventilation until extubation); ICU stay (defined as total time in hours from ICU admission until until transfer to the ward); total hospital stay (days from surgery to discharge); in-hospital mortality; and major adverse cardiovascular events (stroke, myocardial infarction, or all-cause mortality).

• Pulmonary complications included pneumonia, prolonged ventilation ($>$24 hours), or reintubation. Sternal complications included superficial or deep sternal wound infection, wound dehiscence, or sternal instability. Renal impairment was defined as a postoperative increase in serum creatinine of $>$50% from baseline or the need for dialysis.

2.8 Statistical Analysis

All analyses followed the intention-to-treat (ITT) principle. A per-protocol (PP) analysis was also performed for sensitivity.

Sample size was calculated assuming a 25% incidence of POAF in controls and a 10% incidence in the PP group, based on prior literature [11,17]. With $\alpha = 0.05$ and 80% power, 94 patients per group were required. To account for dropouts, we targeted 210 patient's total.

The baseline variables listed in Table 1 (including demographic characteristics, comorbidities, and preoperative laboratory and echocardiographic findings). These variables were chosen based on established predictors of POAF in the literature [1–3]. Postoperative outcomes, such as pericardial effusion, cardiac tamponade, pleural effusion, re-exploration, hospital mortality, and other adverse events, were screened during hospitalization and 30 days post operative follow-up. Data collection was performed prospectively, with preoperative variables assessed before surgery, intraoperative variables recorded during surgery, and postoperative variables monitored until discharge and at follow-up for 30 days postoperatively.

All analyses were performed using IBM SPSS Statistics, version 24.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized as mean $\pm$ standard deviation (SD) or median with interquartile range (IQR), depending on distribution, while categorical variables were expressed as counts and percentages. Group comparisons were conducted with Student's t-test or the Mann–Whitney U test for continuous data, and with the chi-square test or Fisher's exact test for categorical data. Effect estimates were presented as risk differences or odds ratios (OR) with corresponding 95% confidence intervals (CI).

Univariate logistic regression was used to identify risk factors for POAF. Multivariable logistic regression adjusted for clinically relevant covariates (e.g., age, sex, hypertension, diabetes, left atrial size, left ventricular ejection fraction (LVEF)), irrespective of univariate significance. A two-tailed p-value < 0.05 was considered statistically significant.

3. Result

Between January 2022 and June 2024, a total of 436 patients were screened for eligibility, of whom 210 were enrolled and randomized: 106 assigned to the PP group and 104 to the control group. The cohort had a median age of 60 years (IQR 50–65), with 78.5% being male. Baseline demographic data and operative characteristics were largely comparable between groups (Table 1).

Table 1. Baseline demographics and intraoperative data of patients.

Variable	Overall (n = 210)	PP group (n = 106)	Control group (n = 104)	*p*-value
Age, years (median, IQR)	60 (50–65)	60 (50–65)	60 (50–65)	0.546
Male sex, n (%)	165 (78.5)	88 (83.0)	77 (74.0)	0.113
Female sex, n (%)	45 (21.5)	18 (17.0)	27 (26.0)	
Hypertension, n (%)	106 (50.5)	54 (50.9)	52 (50.0)	0.891
Diabetes mellitus, n (%)	89 (42.4)	49 (46.2)	40 (38.5)	0.255
Current/recent smoker, n (%)	61 (29.0)	31 (29.2)	30 (28.8)	0.949
COPD, n (%)	13 (6.2)	6 (5.7)	7 (6.7)	0.748
PAD*, n (%)	4 (1.9)	2 (1.9)	2 (1.9)	1.000
Prior MI, n (%)	153 (72.9)	82 (77.4)	71 (68.3)	0.139
Prior stroke/TIA, n (%)	13 (6.2)	9 (8.5)	4 (3.8)	0.163
CHF (NYHA II–IV), n (%)	89 (42.4)	48 (45.3)	41 (39.4)	0.390
Haematocrit, % (median, IQR)	38.9 (35.4–40.8)	38.9 (35.7–41.0)	38.8 (35.0–40.0)	0.690
Creatinine, mg/dL (median, IQR)	1.0 (0.8–1.1)	0.9 (0.8–1.1)	1.0 (0.8–1.1)	0.460
LVEF, % (median, IQR)	51 (43–60)	50 (41.7–55.5)	54 (45–61)	0.022
LA size, cm (median, IQR)	4.0 (3.5–4.2)	4.0 (3.5–4.2)	3.7 (3.3–4.2)	0.022
CABG, n (%)	175 (83.3)	87 (82.1)	88 (84.6)	
Aortic valve/ascending aorta, n (%)	18 (8.6)	8 (7.5)	10 (9.6)	0.432
CABG + aortic procedure, n (%)	17 (8.1)	11 (10.4)	6 (5.8)	
No. of grafts (mean ± SD)**	3.23 ± 0.71	3.30 ± 0.66	3.14 ± 0.76	0.125
Cross-clamp time, min (median, IQR)	68 (55–85)	69.5 (58–85)	64 (51–85)	0.051
CPB time, min (median, IQR)	100 (89–123)	98 (89–116)	104 (89–132)	0.111
Operative time, min (median, IQR)	180 (160–210)	178 (154–195)	195 (175–228)	<0.001

PP, posterior pericardiotomy; COPD, chronic obstructive pulmonary disease; PAD, peripheral arterial disease; MI, myocardial infarction; TIA, transient ischemic attack; CHF, congestive heart failure; NYHA, New York Heart Association; LVEF, left ventricular ejection fraction; LA, left atrium; CABG, coronary artery bypass grafting; CPB, cardiopulmonary bypass. *Fisher's exact test applied for PAD due to low expected counts. ***p*-value calculated among all patients who underwent CABG (CABG alone or Combination, N = 192).

Overall, baseline demographics and intraoperative variables were well matched between groups, with the exception of minor differences in echocardiographic parameters and operative duration.

3.1 Primary and Secondary Outcomes

The incidence of POAF was significantly reduced in the PP group compared with controls (8.5% vs. 22.1%; OR 0.32, 95% CI 0.14–0.71; $p = 0.006$) (Table 2).

Among secondary endpoints, the need for antiarrhythmic therapy was lower in the PP group (7.5% vs. 22.1%; OR 0.28, 95% CI 0.11–0.67; $p = 0.003$), as was the requirement for systemic anticoagulation (5.6% vs. 12.5%; OR 0.41, 95% CI 0.15–0.97; $p = 0.040$). Electrical cardioversion was infrequent, with no significant difference between groups (0% vs. 0.6%; $p = 0.32$).

Patients in the PP group also demonstrated shorter ventilation times and ICU stays. Median ventilation time was 3.0 hours (IQR 3.0–4.0) versus 4.0 hours (IQR 3.0–6.0) in controls ($p < 0.001$). Median ICU stay was 23.0 hours (IQR 22.0–24.0) compared with 24.0 hours (IQR 22.2–45.0) in the control group ($p = 0.004$).

Postoperative chest drainage during ICU stay was significantly lower in the PP group (median 410 mL, IQR 300–550) than in controls (median 490 mL, IQR 340–707; $p = 0.014$). However, cumulative drainage during hospitalization did not differ significantly ($p = 0.165$). Median hospital stay was 6 days in both groups ($p = 0.099$), and readmission rates were comparable (10.4% vs. 11.5%; $p = 0.788$).

Posterior pericardiotomy was associated with a marked reduction in pericardial complications compared with the control group. The incidence of pericardial effusion was significantly lower in the PP group (9.4% vs. 39.4%; OR 0.17, 95% CI: 0.08–0.36; $p < 0.001$). No cases of cardiac tamponade occurred among patients who underwent PP, whereas 9.6% of controls were affected ($p = 0.003$). Similarly, the need for surgical re-exploration due to bleeding or tamponade was less common in the PP group (0.9% vs. 6.7%; OR 0.13, 95% CI 0.02–1.03; $p = 0.067$). This difference was mainly attributable to tamponade events, which were absent in the PP group but observed in 5.8% of controls ($p = 0.036$) (Table 3).

Hospital mortality was 0% in the PP group and 4.8% in the control group ($p = 0.067$). This difference was not statistically significant. Postoperative pulmonary complications were lower in the PP group (3.8% vs. 10.6%; $p = 0.056$), although this trend did not reach statistical significance. Rates of sternal complications and renal impairment were comparable between the two groups.

Table 2. Primary and secondary outcomes of patients.

Outcome	Overall	PP group (n = 106)	Control group (n = 104)	*p*-value
Primary outcome				
POAF, n (%)	32 (15.2)	9 (8.5)	23 (22.1)	0.006
Secondary outcomes				
Antiarrhythmic medication*, n (%)	31 (14.8)	8 (7.5)	23 (22.1)	0.003
Systemic anticoagulation*, n (%)	19 (9.0)	6 (5.6)	13 (12.5)	0.040
Electrical cardioversion, n (%)	1 (0.5)	0 (0.0)	1 (0.6)	0.320
Ventilation time, hr. (median, IQR)	3.0 (3.0–4.5)	3.0 (3.0–4.0)	4.0 (3.0–6.0)	<0.001
ICU stay, hr. (median, IQR)	24.0 (22.0–29.0)	23.0 (22.0–24.0)	24.0 (22.2–45.0)	0.004
Chest drains output (ICU), mL (median, IQR)	445 (330–600)	410 (300–550)	490 (340–707)	0.014
Total chest drainage, mL (median, IQR)	670 (500–880)	660 (500–850)	695 (519–930)	0.165
Hospital stays, days (median, IQR)	6.0 (5.0–7.0)	6.0 (5.0–7.0)	6.0 (5.0–7.8)	0.099
Readmission, n (%)	23 (11.0)	11 (10.4)	12 (11.5)	0.788

PP, posterior pericardiotomy; POAF, postoperative atrial fibrillation; ICU, intensive care unit. *Refers to treatment administered for POAF.

Table 3. Postoperative outcomes in patients undergoing cardiac surgery with or without PP.

Outcome	Overall	PP group (n = 106)	Control group (n = 104)	*p*-value
Pericardial effusion, n (%)	51 (24.3)	10 (9.4)	41 (39.4)	<0.001
Cardiac tamponade, n (%)	10 (4.8)	0 (0.0)	10 (9.6)	0.003
Left pleural effusion, n (%)	47 (22.4)	26 (25.0)	21 (19.8)	0.367
Re-exploration, n (%)	8 (3.8)	1 (0.9)	7 (6.7)	0.067
– for bleeding	2 (1.0)	1 (0.9)	1 (0.9)	1.000
– for tamponade	6 (2.9)	0 (0.0)	6 (5.8)	0.036
Hospital mortality, n (%)	5 (2.4)	0 (0.0)	5 (4.8)	0.067
Adverse events, n (%)	8 (3.8)	2 (1.9)	6 (5.8)	0.267
Pulmonary complications, n (%)	15 (7.1)	4 (3.8)	11 (10.6)	0.056
Sternal complications, n (%)	13 (6.2)	7 (6.6)	6 (5.8)	0.802
Renal impairment, n (%)	18 (8.6)	7 (6.6)	11 (10.6)	0.304

Data are presented as n (%). PP, posterior pericardiotomy. Chisquare test with continuity correction was used for categorical variables (Fisher's exact test applied when expected frequency <5).

3.2 Risk Factor Analysis

On univariate analysis, PP was associated with a reduced risk of POAF (OR 0.48, 95% CI 0.25–0.90; p = 0.022). No other baseline or operative characteristics (age, sex, comorbidities, left atrial size, LVEF, operative times) were significantly associated with POAF (Table 4). In multivariable analysis adjusting for clinically relevant covariates (age, sex, hypertension, diabetes, left atrial size, LVEF, surgical type), PP remained an independent protective factor against POAF (adjusted OR 0.194, 95% CI 0.06–0.62; p = 0.006).

4. Discussion

Our findings are consistent with previous randomized controlled trials and meta-analyses demonstrating the protective effect of posterior pericardiotomy in reducing POAF [18–23]. Gaudino *et al*. [24] reported that posterior pericardiotomy significantly reduced the incidence of pericardial effusion and POAF after cardiac surgery. Similarly, Amr and Elkassas [21], Ahmad *et al*. [25], and Zhao *et al*. [26], all confirmed that PP is associated with a lower risk of POAF without increasing surgical complications.

Some earlier studies, such as Asimakopoulos *et al*. [7] and Bakhshandeh *et al*. [27], did not observe significant benefit, likely due to smaller sample sizes, heterogeneity, or underpowered designs.

Mechanistically, there are at least two plausible explanations for the reduction in POAF with PP. First, even small postoperative collections of pericardial fluid or thrombi can trigger atrial arrhythmias through local inflammation, oxidative stress, or mechanical compression [6,28]. By providing continuous drainage into the pleural space, PP minimizes these triggers. Second, pericardiotomy itself may subtly alter atrial geometry and hemodynamics, reducing susceptibility to arrhythmic triggers, though this hypothesis requires further echocardiographic validation [24].

In line with earlier reports (e.g., Zhao *et al*., 2014 [26]; Ebaid *et al*., 2021 [29]; Ekim *et al*., 2006 [23]), we observed significantly fewer cases of pericardial effusion and cardiac tamponade in the PP group ($p < 0.001$), reinforcing the mechanical benefit of PP in facilitating posterior pericardial drainage. Our zero incidence of tamponade in the PP group further confirms its protective effect, as similarly shown in trials by Erdil *et al*. [30] and Kaya *et al*. [31].

Table 4. Univariate logistic regression analysis of perioperative risk factors for POAF.

Variable	POAF (n = 32)	No POAF (n = 178)	OR (95% CI)	*p*-value
Age, years (mean ± SD)	58.6 ± 12.0	56.6 ± 11.3	1.01 (0.98–1.03)	0.626
Female sex, n (%)	5 (15.6)	40 (22.5)	1.05 (0.56–1.97)	0.877
Hypertension, n (%)	13 (40.6)	93 (52.2)	1.55 (0.79–3.07)	0.204
Diabetes mellitus, n (%)	13 (40.6)	76 (42.7)	1.06 (0.54–2.11)	0.859
Smoker, n (%)	6 (18.8)	55 (30.9)	1.51 (0.67–3.39)	0.316
Prior MI, n (%)	27 (84.4)	126 (70.8)	0.67 (0.37–1.24)	0.201
Prior stroke/TIA, n (%)	1 (3.1)	12 (6.7)	5.95 (0.79–44.7)	0.083
COPD, n (%)	3 (9.4)	10 (5.6)	0.63 (0.20–2.00)	0.437
CHF (NYHA II–IV), n (%)	13 (40.6)	76 (42.7)	1.07 (0.58–1.97)	0.824
LA size, cm (median, IQR)	3.6 (3.4–4.1)	4.0 (3.5–4.2)	1.00 (0.76–1.30)	0.974
Haematocrit, % (median, IQR)	39.0 (34.8–40.0)	38.7 (35.7–41.0)	0.96 (0.98–1.02)	0.198
Creatinine, mg/dL (median, IQR)	1.0 (0.8–1.2)	0.9 (0.8–1.2)	0.81 (0.29–2.25)	0.691
LVEF, % (median, IQR)	50 (40.3–59.7)	52 (45–60)	1.00 (0.97–1.03)	0.840
Surgical type (CABG vs. others)	—	—	0.84 (0.50–1.42)	0.508
No. of grafts (mean ± SD)	3.25 ± 0.75	3.23 ± 0.71	1.07 (0.61–1.88)	0.824
Posterior pericardiotomy, n (%)	9 (28.1)	97 (54.5)	0.48 (0.25–0.90)	0.022
Cross-clamp time, min (median, IQR)	69 (55–86)	67 (55–85)	1.00 (0.98–1.01)	0.578
CPB time, min (median, IQR)	100 (90–120)	100 (89–123)	1.00 (0.99–1.01)	0.500
Operative time, min (median, IQR)	180 (165–223)	180 (160–210)	1.00 (0.99–1.01)	0.904

POAF, postoperative atrial fibrillation; MI, myocardial infarction; TIA, transient ischemic attack; COPD, chronic obstructive pulmonary disease; CHF, congestive heart failure; NYHA, New York Heart Association; LA, left atrium; LVEF, left ventricular ejection fraction; CABG, coronary artery bypass grafting; CPB, cardiopulmonary bypass. Odds ratios are from univariate logistic regression.

While some RCTs (e.g., Zhao *et al*. [26], and Kaygin *et al*., 2011 [32]) reported a higher incidence of pleural effusion in the PP group, we found no significant difference in pleural effusion rates between groups ($p = 0.367$), suggesting that with proper chest tube placement, PP does not increase the risk of pleural fluid accumulation.

Importantly, our study also evaluated key secondary outcomes. Patients in the PP group experienced shorter ICU stays (1.16 vs. 1.46 days, $p = 0.004$), shorter overall hospitalization (6.6 vs. 8.1 days), and lower in-hospital mortality (0% vs. 4.8%, $p = 0.067$). These improvements mirror findings in trials such as those by Erdil *et al*. [30] and Kaya *et al*. [31], which demonstrated better recovery metrics and reduced complication rates. The finding of lower hospital mortality in the PP group (0% vs. 4.8%) is noteworthy but should be interpreted cautiously. The small number of deaths limits the ability to attribute mortality differences directly to PP. However, the reduction in tamponade and re-exploration rates likely contributed to greater hemodynamic stability and fewer complications, which may explain this observation.

5. Limitation

This trial has several limitations. First, it was a single-center study performed by a single surgeon, which may limit generalizability. Second, this study did not evaluate the duration of POAF episodes, which may also influence clinical outcomes. Future studies should assess the duration of POAF to clarify whether PP reduces overall arrhythmic burden. Finally, a small proportion of patients were lost to follow-up, which may have introduced bias. In addition, follow-up was limited to 30 days, consistent with the majority of published studies on POAF.

6. Conclusion

Posterior pericardiotomy was associated with a significantly lower incidence of POAF, pericardial effusion, and cardiac tamponade in patients undergoing CABG, aortic valve, or ascending aortic surgery. These findings, derived from the first randomized trial conducted in Yemen, suggest that PP is a safe and effective adjunct to cardiac surgery. Larger multicenter randomized trials are needed to confirm whether the observed benefits extend to broader populations and translate into consistent reductions in mortality and other major adverse outcomes.

Availability of Data and Materials

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

IA and AAA designed the research study. IA collected, managed, and analyzed the data. NA prepared the tables. MAK and TN reviewed, edited the manuscript, and interpreted the results. IA drafted the manuscript. All authors contributed to critical revision of the manuscript for important intellectual content. All authors read and ap-

proved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was granted by the Research Ethics Committee of the Cardiovascular and Kidney Transplantation Centre, Taiz University, Yemen (Approval ID 0030425, dated December 20, 2021). Written informed consent was obtained from all participants prior to enrollment. The trial is registered on ClinicalTrials.gov under the identifier NCT07266935, https://clinicaltrials.gov/study/NCT07266935 and is registered on Yemen Clinical Research Registry (YCRR) under ID 20210411.

Acknowledgment

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

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