Interdisciplinary CardioVascular and Thoracic Surgery 2025, 40(5), ivaf105
https://doi.org/10.1093/icvts/ivaf105 Advance Access publication 28 April 2025

Cite this article as: Hamiko M, Spaeth A, Alirezaei H, Krasivskyi I, Rogaczewski J, Silaschi M *et al*. Posterior left pericardiotomy for prevention of re-thoracotomy and postoperative atrial fibrillation in aortic surgery. Interdiscip CardioVasc Thorac Surg 2025; doi:10.1093/icvts/ivaf105.

Posterior left pericardiotomy for prevention of re-thoracotomy and postoperative atrial fibrillation in aortic surgery

Marwan Hamiko *, Andre Spaeth, Hossien Alirezaei, Ihor Krasivskyi, Julia Rogaczewski, Miriam Silaschi, Jacqueline Kruse, Saad Salamate, Ali El-Sayed Ahmad and Farhad Bakhtiary

Department of Cardiac Surgery, University Heart Center Bonn, Bonn, Germany

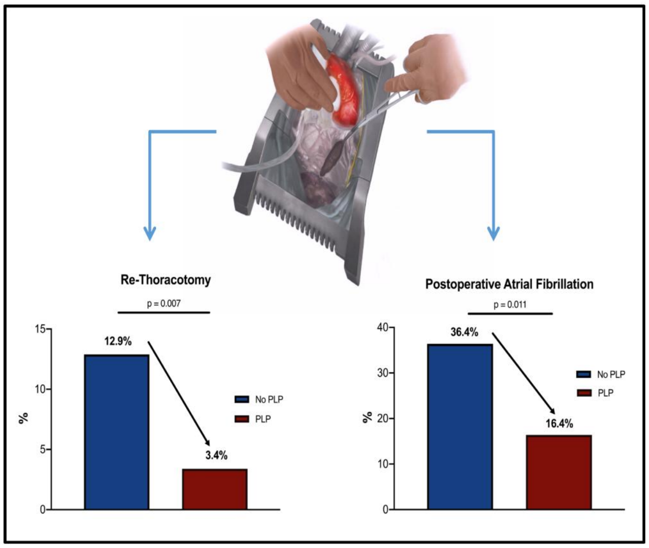
*Corresponding author. Tel: +0049228-28711136; fax: +00228-28711634. e-mail: marwan.hamiko@ukbonn.de (M. Hamiko).

Received 25 November 2024; received in revised form 6 March 2025; accepted 25 April 2025

Posterior Left Pericardiotomy for Prevention of Re-thoracotomy and Postoperative Atrial Fibrillation in Aortic Surgery

Summary

This retrospective study included 256 patients underwent elective aortic surgery. Based on additionally performed PLP during surgery, incidence of re-thoracotomy and postoperative AF was evaluated, using PSM. PLP is a simple and useful surgical technique potentially reducing re-thoracotomy and postoperative AF in aortic surgery patients without associated complications.



AF: Atrial fibrillation; PLP: posterior left pericardiotomy; PSM: propensity score matching.

Abstract

OBJECTIVES: Re-thoracotomy due to pericardial effusion is a frequent complication after aortic surgery, leading to prolonged intensive care unit (ICU) and hospital stays and adverse outcomes. This study aims to evaluate the frequency of re-thoracotomy and postoperative atrial fibrillation in patients undergoing ascending aorta replacement with or without posterior left pericardiotomy.

METHODS: We retrospectively analysed clinical data from patients who underwent elective ascending aorta replacement with or without aortic root between January 2014 and June 2024. Patients were divided into two groups based on posterior left pericardiotomy. We assessed re-thoracotomy due to bleeding or pericardial effusion, postoperative atrial fibrillation, ICU and in-hospital stay, as well as mortality rates, adjusting for confounders using propensity score matching.

RESULTS: A total of 256 patients could be included ($n = 140$ without and $n = 116$ with posterior left pericardiotomy). Mean age was 61.6 ± 12.2 years, with 27.7% female patients. After matching, re-thoracotomy (12.9% vs 3.4%; $P = 0.007$) and postoperative atrial fibrillation (36.4% vs 16.4%; $P = 0.011$) were higher in patients without pericardiotomy. Thirty-day and 1-year mortality were 1.3% and 4.2%, respectively. Posterior left pericardiotomy was associated with shorter ventilation time (8.0 vs 15.0 hours; $P < 0.001$) and hospital stay (8.0 vs 12.0 days; $P < 0.001$). Similar results were observed between the unmatched and the matched cohort.

CONCLUSIONS: Posterior left pericardiotomy is a simple surgical manoeuvre associated with lower rates of re-thoracotomy and postoperative atrial fibrillation in elective aortic surgery patients in a retrospective cohort. Further prospective randomized trials should be performed to confirm and highlight the results from our study.

Keywords: posterior left pericardiotomy • aortic surgery • pericardial effusion • re-thoracotomy • atrial fibrillation

ABBREVIATIONS

AA	Ascending aorta
AAR	Ascending aorta replacement
AF	Atrial fibrillation
AVR	Aortic valve replacement
BMI	Body mass index
CABG	Coronary artery bypass grafting
CAD	Coronary artery disease
COPD	Chronic obstructive pulmonary disease
CPB	Cardiopulmonary bypass
CT	Computer tomography
CVD	Cerebrovascular disease
ECMO	Extracorporeal membrane oxygenation
EuroScore II	European System for Cardiac Operative Risk Evaluation II
ICU	Intensive care unit
IMC	Intermediate care unit
LVEF	Left ventricular ejection fraction
NYHA	New York Heart Association
PE	Pericardial effusion
PLP	Posterior left pericardiotomy
PSM	Propensity score matching
PVD	Peripherial vascular disease
RBC	Red blood cell

INTRODUCTION

Surgeries on the ascending aorta (AA) and aortic root are complex, often leading to postoperative bleeding and pericardial effusion (PE), which can progress to cardiac tamponade, a dangerous condition impairing heart function and causing multiple organ failure. Even minor, circumferential PE can disturb haemodynamics by reducing atrial or ventricular filling. Additionally, recent studies show a higher incidence of postoperative atrial fibrillation (AF) in patients with postcardiotomy PE, with AF rates reaching 20–50% after coronary artery bypass grafting (CABG) and even higher in combined CABG and valve surgeries [1, 2]. Cardiac tamponade and re-thoracotomy due to bleeding after aortic surgery significantly increase intensive care unit (ICU) stay, hospital morbidity, mortality and costs [3–5].

In 1995, Mulay *et al.* introduced posterior left pericardiotomy (PLP) to drain pericardial fluid into the left pleural space, reducing PE and postoperative AF, with further studies supporting its effectiveness [6–10].

However, no research has examined the impact of PLP on re-thoracotomy and AF specifically in aortic surgeries. Since 2021, we routinely apply PLP in aortic surgery. This study aims to present our experience with PLP and compare patient outcomes to evaluate its effectiveness in preventing re-thoracotomy and postoperative AF in aortic surgery.

PATIENTS AND METHODS

Ethical statement

The study was approved by the internal Ethical Committee (No. 358/23-EP, October 24, 2023) and followed the Helsinki Declaration. Informed patient consent was waived due to the retrospective, anonymized study design. Data collection and storage followed the WMA Declaration of Taipei.

Patients and study groups

Data from patients scheduled for supracoronary ascending aorta replacement (AAR), aortic valve reconstruction (David procedure) or aortic valve replacement (AVR) as Wheat or Bentall procedure were retrospectively analysed from January 2014 to June 2024. Indication for surgery has been included as Supplementary Material and is in accordance with the current ESC/EACTS guidelines [11]. Patients with acute/chronic aortic dissection, complete arch replacement, redo surgery, multiple valve surgery or additional CABG as well as patient received AAR via minimally invasive approach were excluded. Baseline characteristics, intraoperative details and postoperative outcomes were analysed using institutional records, and preoperative risk (EuroScore II = European System for Cardiac Operative Risk Evaluation) was retrospectively calculated.

According to the addition of PLP to the aortic procedures, patients were divided into two groups:

PLP: patients with PLP
No PLP: patients without PLP

Primary and secondary end-points of the study

Primary end-points of the study were re-thoracotomy due to bleeding or PE leading to pericardial tamponade and new-onset postoperative AF. Thirty-day mortality was defined as secondary end-point of the study.

Surgical procedure

All surgeries were performed via median sternotomy. For patients with additional aortic valve pathology, the Wheat, Bentall or David procedure was chosen based on valve morphology, patient age and surgeon experience. For biological Bentall procedures, a biological conduit (graft size 5 mm larger than the valve prosthesis) was used.

After completing the main surgery but before ending cardiopulmonary bypass (CPB), a 4–5 cm incision was made in the posterolateral pericardium from the left inferior pulmonary vein to the diaphragm, preserving the phrenic nerve, in patients selected

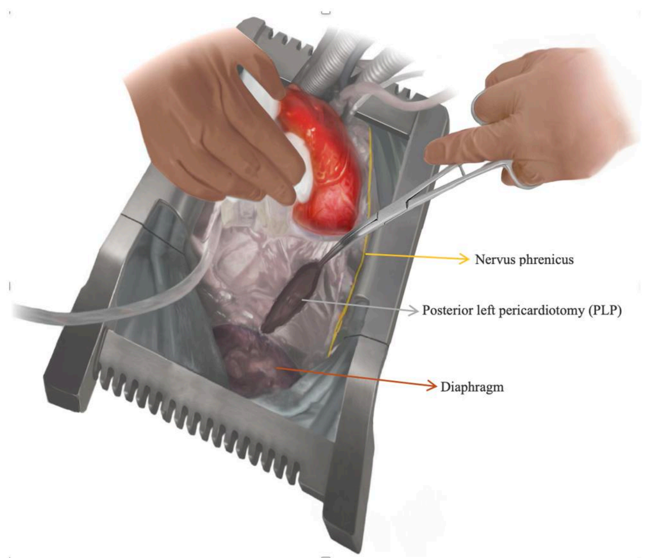


Figure 1: Illustration of the posterior left pericardiotomy (PLP) manoeuvre configurated with safe distance to the phrenic nerve and the diaphragm

for PLP (Fig. 1). As standard practice, in every patient, both pleural cavities were opened and drained with single chest tube in addition to the substernal drainage. All patients without PLP received additionally a standard chest tube, which was placed in the pericardial cavity. Patients who underwent the PLP manoeuvre did not receive an additional drain in the pericardial cavity. Selection criteria for PLP are included as Supplementary Material.

Postoperative care and outcome

Every patient was monitored for acute bleeding during ICU stay in the first 24 hours. According to institutional policy, acute bleeding was defined as blood loss exceeding 400 ml/hour within the first three hours postoperatively. All drainages were removed on the second postoperative day. Indication for re-thoracotomy was defined as acute bleeding, PE and tamponade in the first hours during ICU stay or delayed PE leading to pericardial tamponade. Intra- and postoperative data, including aortic cross-clamping and CPB time, ventilation duration, ICU and hospital stay, and 30-day and 1-year mortality, were analysed. Additionally, re-thoracotomy rates, red blood cells (RBCs) transfusion and postoperative bleeding amount during the first 24 hours were evaluated. PE leading to cardiac tamponade was diagnosed using haemodynamic and echocardiographic data. Furthermore, new-onset occurrence of postoperative AF as well as the occurrence of post-drainage left-sided pleural effusion needing evacuation were recorded. Definition and management of postoperative AF were included as Supplementary Material. Further adverse events were recorded as part of the outcome assessment.

Follow-up data

During follow-up, all patients were regularly contacted at 30-day and at 1-year postoperatively. Follow-up data were obtained through telephone contact and included questions on survival and aortic reintervention.

Statistical analysis

Depending on the distribution normality, continuous variables were presented as mean with standard deviation (SD) or as median [interquartile range] (IQR). Normality was visually assessed using a QQ plot and tested with the Shapiro–Wilk test. Categorical data were reported as absolute counts (n) and percentages. To reduce bias in this retrospective study, propensity score matching (PSM) was performed, estimating scores through logistic regression adjusted for eleven baseline variables: age, diabetes, hypertension, coronary artery disease (CAD), left ventricular ejection fraction (LVEF), EuroScore II, sex, peripheral vascular disease (PVD), type of procedure, chronic kidney disease and New York Heart Association (NYHA) classification. Matching utilized 1:1 nearest neighbour matching without replacement and a caliper of 0.2. The standardized mean difference (SMD) was calculated post-matching to assess group balance, with an acceptable difference set at less than 0.1. Continuous variables before matching were compared using t-tests or Mann–Whitney tests, and categorical outcomes were compared with Pearson's chi-square test or Fischer's exact test. After matching, comparisons were made using paired t-tests or the Wilcoxon signed-rank test for continuous variables, and the McNemar's test for categorical outcomes. A *P*-value of less than 0.05 was considered statistically significant. Analyses were performed with GraphPad Prism version 8.4.3 and R version 4.4.0 (R Foundation for Statistical Computing, Vienna, Austria), with PSM performed via the MatchIt package version 4.5.5 (https://cran.r-project.org/web/packages/MatchIt/index.html).

RESULTS

A total of 256 patients could be included in the actual study ($n = 140$ patients without and $n = 116$ patients with intraoperative performed PLP). Baseline characteristics, comorbidities and preoperative parameters are summarized in Table 1 for unmatched and matched groups. PSM resulted in a total of 93 patients in each group.

Before matching, the mean age was 61.6 (SD: 12.2) years, with 185 males (72.3%) and 71 females (27.7%). The median EuroScore II was 2.7% (range: 1.9–4.3%). In the matched cohort, demographic data and medical history were comparable, except for a higher incidence of chronic kidney disease in the PLP group.

The median preoperative aortic diameter was 52.0 mm (range: 50.0 to 56.0 mm). Echocardiographic assessments showed normal LVEF in 214 patients (83.6%). Among patients undergoing AVR, aortic regurgitation and stenosis were noted in 124 (48.4%) and 85 (33.2%) patients, respectively. Bicuspid aortic valve was present in 101 patients (39.5%). Most of the patients presented with dyspnoea according to NYHA class II and III.

Surgical procedures and intraoperative data are detailed in Table 2. The Wheat procedure was performed in over half of the patients, while Bentall and David procedures were conducted in 38 (14.8%) and 15 (5.9%) patients, respectively. Both CPB and aortic cross-clamp times were significantly shorter in the PLP group. Impact of CPB and aortic cross-clamping times on re-thoracotomy and AF were included as Supplementary Material.

Table 1: Patients characteristics and pre-existing conditions

	Before PSM				After PSM		
	Overall ($n = 256$)	No PLP ($n = 140$)	PLP ($n = 116$)	SMD	No PLP ($n = 93$)	PLP ($n = 93$)	SMD
Baseline data							
Age (years)	61.6 (SD: 12.2)	61.2 (SD: 11.9)	62.1 (SD: 12.6)	0.070	61.4 (SD: 12.1)	61.7 (SD: 12.8)	0.018
Female gender	71 (27.7)	42 (30.0)	29 (25.0)	0.112	23 (24.7)	23 (24.7)	<0.001
BMI (kg/m^2)	28.1 (SD: 5.5)	27.8 (SD: 5.8)	28.4 (SD: 5.1)	0.101	27.4 (SD: 5.9)	28.4 (SD: 5.0)	0.246
EuroScore II (%)	2.7 [1.9, 4.3]	2.6 [1.8, 3.7]	2.8 [2.0, 4.7]	0.281	2.7 [1.9, 3.8]	2.7 [2.0, 4.4]	0.084
Previous medical history							
Arterial hypertension	217 (84.8)	120 (85.7)	97 (83.6)	0.058	78 (83.9)	81 (87.1)	0.087
Hyperlipidaemia	137 (53.5)	79 (56.4)	58 (50.0)	0.129	52 (55.9)	46 (49.5)	0.129
Smoker	84 (32.8)	50 (35.7)	34 (29.3)	0.137	34 (36.6)	28 (30.1)	0.137
Diabetes mellitus	23 (9.0)	10 (7.1)	13 (11.2)	0.141	8 (8.6)	9 (9.7)	0.034
CAD	41 (16.0)	19 (13.6)	22 (19.0)	0.147	16 (17.2)	16 (17.2)	<0.001
COPD	38 (14.8)	23 (16.4)	15 (12.9)	0.099	14 (15.1)	13 (14.0)	0.031
PVD	11 (4.3)	6 (4.3)	5 (4.3)	0.001	3 (3.2)	4 (4.3)	0.053
CVD	11 (4.3)	6 (4.3)	5 (4.3)	0.001	3 (3.2)	5 (5.4)	0.100
Previous stroke	15 (5.9)	7 (5.0)	8 (6.9)	0.080	4 (4.3)	8 (8.6)	0.176
Atrial fibrillation	59 (23.0)	32 (22.9)	27 (23.3)	0.010	24 (25.8)	22 (23.7)	0.050
Chronic kidney failure	25 (9.8)	7 (5.0)	18 (15.5)	0.352	7 (7.5)	10 (10.8)	0.089
Marfan's disease	6 (2.3)	4 (2.9)	2 (1.7)	0.076	3 (3.2)	1 (1.1)	0.149
Preoperative measurement and echocardiography							
Diameter of the AA (mm)	52.0 [50.0, 56.0]	54.0 [50.0, 58.0]	51.0 [48.0, 54.0]	0.414	54.0 [50.0, 58.0]	51.0 [48.0, 54.0]	0.481
Aortic valve pathology							
Aortic regurgitation	124 (48.4)	63 (45.0)	61 (52.6)	0.152	47 (50.5)	48 (51.6)	0.022
Aortic stenosis	85 (33.2)	45 (32.1)	40 (34.5)	0.049	36 (38.7)	32 (34.4)	0.090
Bicuspid aortic valve	101 (39.5)	52 (37.1)	49 (42.2)	0.104	36 (38.7)	42 (45.2)	0.130
LVEF							
>50%	214 (83.6)	122 (87.1)	92 (79.3)	0.193	80 (86.0)	78 (83.9)	0.053
30–50%	35 (13.7)	13 (9.3)	22 (19.0)	0.247	10 (10.8)	13 (14.0)	0.082
<30%	7 (2.7)	5 (3.6)	2 (1.7)	0.142	3 (3.2)	2 (2.2)	0.082
Clinical presentation							
NYHA classification							
I	20 (7.8)	14 (10.0)	6 (5.2)	0.154	7 (7.5)	6 (6.5)	0.049
II	110 (43.0)	56 (40.0)	54 (46.6)	0.131	43 (46.2)	42 (45.2)	0.022
III	124 (48.4)	69 (49.3)	55 (47.4)	0.038	42 (45.2)	44 (47.3)	0.043
IV	2 (0.8)	1 (0.7)	1 (0.9)	0.016	1 (1.1)	1 (1.1)	<0.001

Data are presented as median [interquartile range], *n* (%) or mean with standard deviation (SD).

AA: ascending aorta; BMI: body mass index; CAD: coronary artery disease; COPD: chronic obstructive pulmonary disease; CVD: cerebrovascular disease; EuroScore II: European System for Cardiac Operative Risk Evaluation II; LVEF: left ventricular ejection fraction; NYHA: New York Heart Association; PLP: posterior left pericardiotomy; PSM: propensity score matching; PVD: peripherial vascular disease; SMD: standardized mean difference.

Postoperative outcome and follow-up

In the unmatched group, postoperative PE occurred in 27 patients (10.5%), with 22 (8.6%) requiring re-thoracotomy due to acute bleeding and cardiac tamponade. The re-thoracotomy rate was significantly lower in the PLP group (no PLP: 12.9% vs PLP: 3.4%; $P = 0.007$, Fig. 2A), and postoperative AF was also less frequent in the PLP group (no PLP: 36.4% vs PLP: 16.4%; $P = 0.011$, Fig. 2B). After matching, these rates remained significantly lower for the PLP group.

Intra- and postoperative bleeding amounts detected via chest tubes in the first 24 hours postoperatively were comparable between both groups (no PLP: 545 ml vs PLP: 605 ml; $P = 0.596$, Fig. 3), as well as the need for RBC transfusion (no PLP: 1.2 units vs PLP: 0.9 units; $P = 0.274$).

Postoperative left-sided pleural effusions requiring additional puncture occurred in 11 patients (9.5%) in the PLP group and 16 patients (11.4%) in the group without PLP and were statistically not significant ($P = 0.614$). Injury of the phrenic nerve was zero in the PLP group.

Table 3 highlights further postoperative complications and mortality rates for both groups, which were similar in the unmatched and matched populations.

In the unmatched group, mean mechanical ventilation time was 32.5 (SD: 122.2) hours. Median stay at the ICU was 24 hours (range: 24.0 to 72.0 hours), and the patients were discharged after a median stay of 10.0 days (range: 7.0 to 14.0 days). Ventilation time and in-hospital stay were significantly lower in the PLP group, both prior and after PSM.

Of total cohort, 91.4% and 74.6% could be followed up 30-day and 1-year postoperatively. Thirty-day and 1-year mortality rates were not significantly different between the groups before or after matching. Figure 4 shows the estimated survival rates as Kaplan–Meier curves for both unmatched (4A) and matched cohorts (4B).

DISCUSSION

In this retrospective single-centre study, we found that adding PLP during aortic surgery is associated with a significant

Table 2: Procedural details

		Before PSM			After PSM		
	Overall (*n* = 256)	No PLP (*n* = 140)	PLP (*n* = 116)	SMD	No PLP (*n* = 93)	PLP (*n* = 93)	SMD
Surgical procedure							
Supracoronary AAR	35 (13.7)	27 (19.3)	8 (6.9)	0.489	5 (5.4)	8 (8.6)	0.127
Supracoronary AAR with hemiarch replacement	12 (4.7)	5 (3.6)	7 (6.0)	0.103	5 (5.4)	5 (5.4)	***<0.001***
Wheat	135 (52.7)	76 (54.3)	59 (50.9)	0.069	55 (59.1)	51 (54.8)	0.086
Bentall	38 (14.8)	16 (11.4)	22 (19.0)	0.192	14 (15.1)	16 (17.2)	0.055
David	15 (5.9)	9 (6.4)	6 (5.2)	0.057	7 (7.5)	6 (6.5)	0.049
Wheat/Bentall/David with hemiarch replacement	21 (8.2)	7 (5.0)	14 (12.1)	0.217	7 (7.5)	7 (7.5)	***<0.001***
Intraoperative data				*P*-value			*P*-value
CPB time (min)	122.1 (SD: 54.9)	146.7 (SD: 52.4)	92.3 (SD: 41.6)	***<0.001***	156.8 (SD: 54.74)	90.7 (SD: 40.39)	***<0.001***
Aortic cross-clamp time (min)	90.3 (SD: 42.0)	109.4 (SD: 38.9)	67.2 (SD: 33.2)	***<0.001***	116.8 (SD: 38.82)	67.3 (SD: 33.61)	***<0.001***

Data are presented as *n* (%) or mean with standard deviation (SD). Significant changes are displayed in bold and italics.

AAR: ascending aorta replacement; CPB: cardiopulmonary bypass; PLP: posterior left pericardiotomy; PSM: propensity score matching; SMD: standardized mean difference.

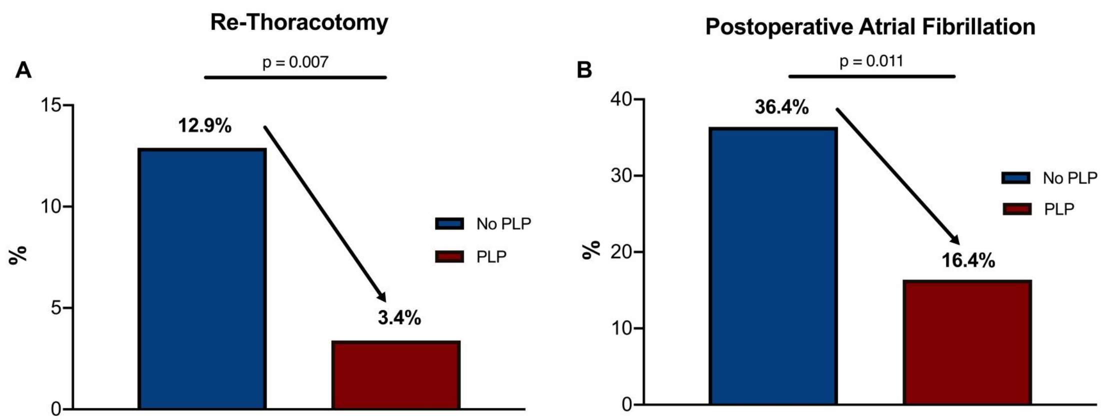


Figure 2: Incidence of re-thoracotomy (**A**) and postoperative AF (**B**) in patients with and patients without posterior left pericardiotomy. Data are presented as percentage. PLP: posterior left pericardiotomy

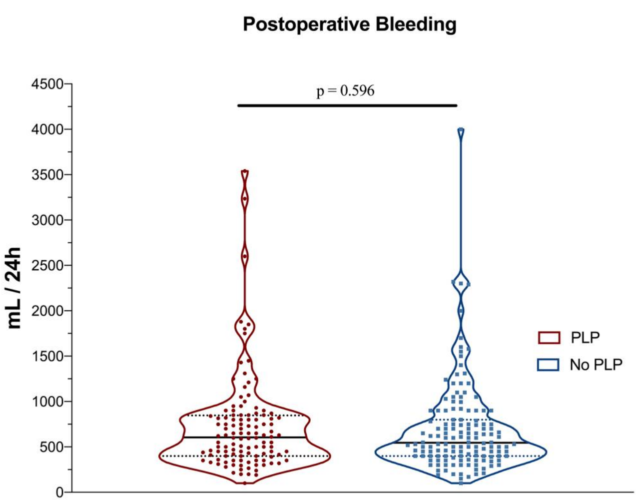


Figure 3: Violine plots show the median (line), first and third quartiles (dotted lines) and individual values as well as their distribution for postoperative bleeding amount in the first 24 hours. PLP: posterior left pericardiotomy

reduction in re-thoracotomy and postoperative AF incidences. No complications from the PLP manoeuvre were reported. Additionally, patients undergoing PLP had shorter ventilation times and earlier hospital discharges, while 30-day and 1-year mortality rates were similar in both matched groups.

To our knowledge, this is the first study to investigate the effect of PLP on the incidence of re-thoracotomy and postoperative AF specifically for aortic surgery.

Postoperative bleeding resulting in PE in mild-to-moderate amounts is common after cardiac surgery and typically reported in echocardiographic studies [9, 12]. The increased intrapericardial pressure from PE may cause haemodynamic disturbances and lead to cardiac tamponade in severe cases, which is associated with hypotension, acute renal failure, arrhythmias, prolonged ICU stays and mortality [3, 13]. Furthermore, PE without signs of tamponade may contribute to postoperative AF. Additional pericardial tubes can drain the posterior space but carry risks like arrhythmias and tube occlusion, limiting their routine use [14, 15].

Table 3: Postoperative outcome and follow-up

		Before PSM			After PSM		
	Overall ($n = 256$)	No PLP ($n = 140$)	PLP ($n = 116$)	*P*-value	No PLP ($n = 93$)	PLP ($n = 93$)	*P*-value
Postoperative outcome							
Re-thoracotomy	22 (8.6)	18 (12.9)	4 (3.4)	***0.007***	15 (16.1)	3 (3.2)	***0.004***
Pericardial effusion	27 (10.5)	21 (15.0)	6 (5.2)	***0.011***	17 (18.3)	5 (5.4)	***0.004***
Left-sided pleural effusion	27 (10.5)	16 (11.4%)	11 (9.5%)	0.614	14 (15.1)	7 (7.5)	0.077
Postoperative AF	70 (27.3)	51 (36.4)	19 (16.4)	***<0.001***	39 (41.9)	16 (17.2)	***<0.001***
Myocardial infarction	2 (0.8)	1 (0.7)	1 (0.9)	>0.999	1 (1.1)	1 (1.1)	>0.999
ECMO	2 (0.8)	2 (1.4)	0 (0.0)	0.502	2 (2.2)	0 (0.0)	0.250
Pneumonia	56 (21.9)	35 (25.0)	21 (18.1)	0.184	23 (24.7)	16 (17.2)	0.229
Re-intubation	12 (4.7)	9 (6.4)	3 (2.6)	0.234	8 (8.6)	2 (2.2)	0.065
Acute kidney injury	4 (1.6)	3 (2.1)	1 (0.9)	0.629	3 (3.2)	1 (1.1)	0.375
Disabling stroke	7 (2.7)	3 (2.1)	4 (3.4)	0.705	3 (3.2)	2 (2.2)	0.688
Delirium	35 (13.7)	18 (12.9)	17 (14.7)	0.677	13 (14.0)	15 (16.1)	0.690
Pacemaker implantation	5 (2.0)	2 (1.4)	3 (2.6)	0.661	1 (1.1)	2 (2.2)	0.625
Wound infection	10 (3.9)	5 (3.6)	5 (4.3)	0.759	4 (4.3)	2 (2.2)	0.453
30-day mortality	3/234 (1.3)	2/126 (1.6)	1/108 (0.9)	>0.999	2/100 (2.0)	1/101 (1.0)	0.621
1-year mortality	8/191 (4.2)	6/118 (5.1)	2/73 (2.7)	0.714	6/92 (6.5)	2/72 (2.8)	0.468
Ventilation time (hours)	13.5 [5.75, 19.0]	15.0 [12.0, 20.00]	8.0 [4.0, 17.0]	***<0.001***	13.5 [5.0, 20.0]	16.0 [13.0, 25.0]	***<0.001***
ICU time (hours)	24.0 [24.0, 72.0]	24.0 [24.0, 72.0]	24.0 [24.0, 72.0]	0.277	24.0 [24.0, 72.0]	24.0 [24.0, 72.0]	***0.015***
In-hospital stay (days)	10.0 [7.00, 14.0]	12.0 [8.0, 15.0]	8.0 [6.0, 12.0]	***<0.001***	13.0 [8.0, 18.0]	8.0 [6.0, 12.0]	***<0.001***
Bleeding in 24 hours (ml)	592.5 [400.0, 825.0]	545.0 [400.0, 800.0]	605.0 [400.0, 842.5]	0.596	610.0 [420.0, 900.0]	550.0 [390.0, 820.0]	0.261
RBC transfusion (unit)	1.1 (SD: 1.9)	1.2 (SD: 2.2)	0.9 (SD: 1.6)	0.274	1.31 (SD: 2.17)	0.97 (SD: 1.75)	0.232

Data are presented as median [interquartile range], *n* (%) or mean with standard deviation (SD). Significant changes are displayed in bold and italics.
AF: atrial fibrillation; ECMO: extracorporeal membrane oxygenation; ICU: intensive care unit; PLP: posterior left pericardiotomy; PSM: propensity score matching; RBC: red blood cell.

Postoperative PE is a recognized trigger for AF, the most common arrhythmia after cardiac surgery, occurring in 20–50% of patients [6, 16, 17]. AF is linked to higher mortality rates, increased heart failure, renal dysfunction, stroke risk, longer hospital stays and elevated healthcare costs [18]. The aetiology of postoperative AF is not completely understood but involve multiple factors such as age, hypertension, obesity, pre-existing heart conditions, surgical trauma, volume overload, ischaemia, electrolyte imbalances and pericardial lesions [19–21].

In 1995, Mulay *et al.* firstly described PLP as a simple procedure to drain fluid from the pericardial space into the left pleural space, demonstrating reduced postoperative PE and related supraventricular arrhythmias in CABG patients [6]. Subsequent studies have reported similar reductions in PE following various adult cardiac surgical procedures [7–10, 16].

Recently, Gaudino *et al.* reported results from a randomized trial involving elective patients undergoing CABG, AVR or aortic surgery, either alone or in combination. They found that the incidence of postoperative AF was significantly lower in the PLP group compared to the non-PLP group (17% vs 33%), with no difference in hospital stay [8]. Although our cohort exclusively included aortic surgery patients, our findings align with Gaudino *et al.* We also observed a significant reduction in postoperative AF (16.4% vs 36.4%) in the PLP group, along with lower rates of re-thoracotomy and PE, resulting in reduced ventilation times and shorter hospital stay.

Patients undergoing complex aortic surgery face a higher risk of developing haemodynamically significant PE due to the procedure's complexity, systemic hypothermia and extensive suture lines, often necessitating re-thoracotomy [4]. Re-thoracotomy is associated with increased mortality, prolonged ventilation and extended ICU and hospital stays, leading to higher costs [4, 5]. Avoiding emergency re-thoracotomy can also reduce the risk of sternal wound complications [4, 5]. In aortic surgery patients, re-thoracotomy rates range from 6% to 16%, depending on the performed procedure. Our cohort show a total re-thoracotomy rate of 8.6%, which is consistent with previous studies [22]. The incidence of re-thoracotomy may be excessively high in the group without PLP (12.4%), but it is within the reported range in the literature for aortic surgery patients [22]. Most prior research on PLP has focused on preventing postoperative AF rather than reducing re-thoracotomy rates [6–10, 16].

The results of Gaudino *et al.* in their randomized PALACS trial prompted us to adopt the PLP strategy for aortic patients and further investigate outcomes. Since 2021, our department has routinely performed additional PLP during aortic surgeries. Despite the standard protocol for PLP in aortic surgery, initially not all surgeons adopted this surgical manoeuvre. However, after observing its benefits, all surgeons in our department now routinely perform PLP in aortic surgery patients. In contrast to our findings, the PALACS study did not show a significant reduction in re-thoracotomy rates, possibly due to the low surgical revision rates for bleeding, reported at only 2% [8].

The shorter CPB and aortic cross-clamping times in the PLP group may contribute to the observed lower re-thoracotomy and AF due to reduced inflammation. However, there were no significant differences in postoperative chest tube bleeding or RBC transfusion rates, suggesting that PLP effectively reduces the risk of developing postoperative PE by facilitating blood drainage from the pericardial to the pleural cavity. The differences in CPB and aortic cross-clamping times may result from the study's retrospective design, using historical data. PLP itself does not affect these times. Logistic regression analysis showed no association between CPB and aortic cross-clamping times and re-thoracotomy or postoperative AF rates. These times may reflect technical advancements in surgery and perioperative management, with PLP being one such recent advancement.

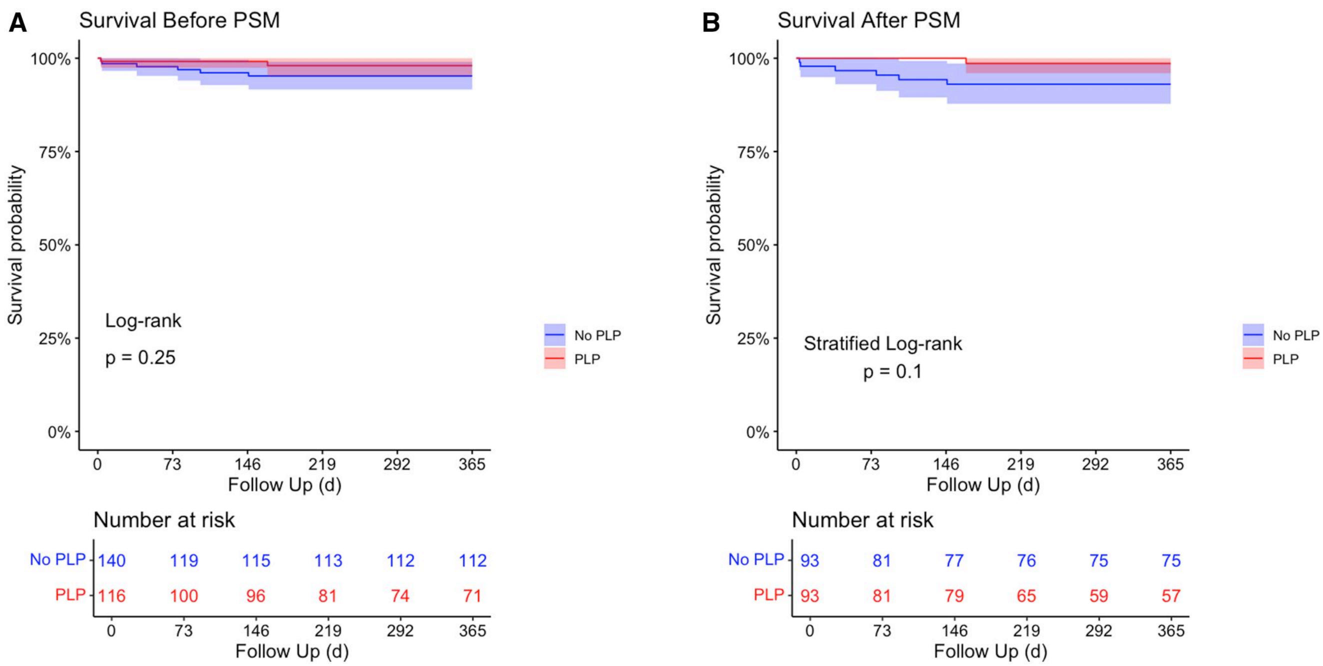


Figure 4: Kaplan–Meier curves estimating postoperative survival for the unmatched (**A**) and the matched (**B**) cohort. Numbers of patients at risk are displayed below. For the matched patients, the stratified log-rank *P*-value was calculated. PLP: posterior left pericardiotomy

Although PLP is a simple procedure, potential risks include injury to the left phrenic nerve, adhesion formation and heart herniation through the incision. However, these complications are rare, and in our experience, the benefits of PLP outweigh the risks. There is a possibility of increased left-sided pleural effusion, which may impact respiratory function and require drainage. A recent meta-analysis reported a higher rate of left-sided pleural effusions in PLP patients but found no increased risk of pulmonary complications [19]. In our study, the no injury of the left phrenic nerve was detected in the PLP group and left-sided pleural effusion occurred in 10.5% of the total cohort without difference between both groups. Our findings align with the PALACS trial, which also showed no significant difference in pleural effusions or complications like phrenic nerve injury [8]. Moreover, patients who underwent PLP in our cohort had significantly shorter ventilation times.

Limitation

This study provides valuable insights but has several limitations that may affect the results. The retrospective, single-centre design and temporal cohort differences present challenges, limiting generalizability and introducing potential selection bias. While PSM was used to balance baseline characteristics, residual confounding may remain. Variability in CPB and aortic cross-clamp times across different surgeons could also impact the results. Surgical strategies have evolved since 2021, and different surgeons performed the procedures, which may have introduced bias due to changes in techniques and experience. Additionally, all patients with PLP were operated on after 2021, while 114 of 140 patients without PLP were treated before, introducing potential bias due to varying surgical practices and hospital protocols.

Conclusion

PLP is a simple and useful surgical technique potentially reducing re-thoracotomy and postoperative AF in aortic surgery patients, with no complications observed. Further multicentre, prospective, randomized studies are needed to confirm and further assess the clinical benefits of PLP in aortic surgery patients.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *ICVTS* online.

FUNDING

No funding was received for conducting this study.

CONFLICT OF INTREST

There is no conflict of interest to declare.

DATA AVAILABILITY

The data supporting the findings of this study will be available from the corresponding author upon reasonable request.

Author contributions

Marwan Hamiko, MD: Conceptualization; Formal analysis; Methodology; Project administration; Validation; Writing—original draft; Writing—review & editing. **Andre Spaeth:** Data curation. **Hossien Alirezaei:** Data curation. **Ihor Krasivskyi:** Software; Statistical analysis. **Julia Rogaczewski:** Data curation.

Miriam Silaschi: Writing—review & editing. **Jacqueline Kruse:** Drafting Fig. 1. **Saad Salamate:** Writing—review & editing. **Ali El-Sayed Ahmad:** Writing—review & editing. **Farhad Bakhtiary:** Project administration; Supervision

Reviewer information

Interdisciplinary CardioVascular and Thoracic Surgery thanks Daniel-Sebastian Dohle, Dimitrios Dougenis and the other, anonymous reviewer(s) for their contribution to the peer review process of this article.

REFERENCES

[1] Eikelboom R, Sanjanwala R, Le ML, Yamashita MH, Arora RC. Postoperative atrial fibrillation after cardiac surgery: a systematic review and meta-analysis. Ann Thorac Surg 2021;111:544–54.
[2] Omae T, Kanmura Y. Management of postoperative atrial fibrillation. J Anesth 2012;26:429–37.
[3] You SC, Shim CY, Hong G-R, *et al*. Incidence, predictors, and clinical outcomes of postoperative cardiac tamponade in patients undergoing heart valve surgery. PLoS One 2016;11:e0165754.
[4] Lazaros G, Vlachopoulos C, Lazarou E, Tousoulis D, Tsioufis CC. Contemporary management of pericardial effusion. Panminerva Med 2021;63:288–300.
[5] Cakalagaoglu C, Koksal C, Baysal A, *et al*. The use of posterior pericardiotomy technique to prevent postoperative pericardial effusion in cardiac surgery. Heart Surg Forum 2012;15:E84–9.
[6] Mulay A, Kirk AJ, Angelini GD, Wisheart JD, Hutter JA. Posterior pericardiotomy reduces the incidence of supra-ventricular arrhythmias following coronary artery bypass surgery. Eur J Cardiothorac Surg 1995;9:150–2.
[7] Gozdek M, Pawliszak W, Hagner W *et al*. Systematic review and meta-analysis of randomized controlled trials assessing safety and efficacy of posterior pericardial drainage in patients undergoing heart surgery. J Thorac Cardiovasc Surg 2017;153:865–75 e12.
[8] Gaudino M, Sanna T, Ballman KV *et al*.; PALACS Investigators. Posterior left pericardiotomy for the prevention of atrial fibrillation after cardiac surgery: an adaptive, single-centre, single-blind, randomised, controlled trial. Lancet 2021;398:2075–83.
[9] Ikaheimo MJ, Huikuri HV, Airaksinen KE *et al*. Pericardial effusion after cardiac surgery: incidence, relation to the type of surgery, antithrombotic therapy, and early coronary bypass graft patency. Am Heart J 1988;116:97–102.
[10] Kaleda VI, McCormack DJ, Shipolini AR. Does posterior pericardiotomy reduce the incidence of atrial fibrillation after coronary artery bypass grafting surgery? Interact CardioVasc Thorac Surg 2012;14:384–9.
[11] Czerny M, Grabenwöger M, Berger T *et al*.; EACTS/STS Scientific Document Group. EACTS/STS guidelines for diagnosing and treating acute and chronic syndromes of the aortic organ. Ann Thorac Surg 2024;118:5.
[12] Wolf MJ, Maher KO, Kanter KR, Kogon BE, Guzzetta NA, Mahle WT. Early postoperative bleeding is independently associated with increased surgical mortality in infants after cardiopulmonary bypass. J Thorac Cardiovasc Surg 2014;148:631–6e1.
[13] Adrichem R, Le Cessie S, Hazekamp MG *et al*. Risk of clinically relevant pericardial effusion after pediatric cardiac surgery. Pediatr Cardiol 2019; 40:585–94.
[14] Arbatli H, Demirsoy E, Aytekin S *et al*. The role of posterior pericardiotomy on the incidence of atrial fibrillation after coronary revascularization. J Cardiovasc Surg (Torino) 2003;44:713–7.
[15] Moss E, Miller CS, Jensen H *et al*. A randomized trial of early versus delayed mediastinal drain removal after cardiac surgery using silastic and conventional tubes. Interact CardioVasc Thorac Surg 2013; 17:110–5.
[16] St-Onge S, Perrault LP, Demers P *et al*. Pericardial blood as a trigger for postoperative atrial fibrillation after cardiac surgery. Ann Thorac Surg 2018;105:321–8.
[17] Dobrev D, Aguilar M, Heijman J, Guichard JB, Nattel S. Postoperative atrial fibrillation: mechanisms, manifestations and management. Nat Rev Cardiol 2019;16:417–36.
[18] LaPar DJ, Speir AM, Crosby IK *et al*.; Investigators for the Virginia Cardiac Surgery Quality Initiative. Postoperative atrial fibrillation significantly increases mortality, hospital readmission, and hospital costs. Ann Thorac Surg 2014;98:527–33; discussion 533.
[19] Soletti GJ, Perezgrovas-Olaria R, Harik L *et al*. Effect of posterior pericardiotomy in cardiac surgery: a systematic review and meta-analysis of randomized controlled trials. Front Cardiovasc Med 2022;9:1090102.
[20] Auer J, Weber T, Berent R, Ng CK, Lamm G, Eber B. Risk factors of postoperative atrial fibrillation after cardiac surgery. J Card Surg 2005; 20:425–31.
[21] Greenberg JW, Lancaster TS, Schuessler RB, Melby SJ. Postoperative atrial fibrillation following cardiac surgery: a persistent complication. Eur J Cardiothorac Surg 2017;52:665–72.
[22] Svensson LG, Pillai ST, Rajeswaran J *et al*. Long-term survival, valve durability, and reoperation for 4 aortic root procedures combined with ascending aorta replacement. J Thorac Cardiovasc Surg 2016;151: 764–74 e4.

Interdisciplinary CardioVascular and Thoracic Surgery, 2025, 40, 1–8
https://doi.org/10.1093/icvts/ivaf105
Original article