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# Preventive Role of Posterior Pericardiotomy in Early Post-Cardiac Surgery Atrial Fibrillation and Pericardial Collection

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## ABSTRACT

**Background:** Postoperative atrial fibrillation is common problem after cardiac surgeries. It is related to the rise in morbidity & hospital costs.

**Objective:** The goal of the research was to assess the effectiveness of posterior pericardiotomy in reducing the incidence of postoperative pericardial effusion & consequently decreasing the related atrial fibrillation.

**Subjects and Methods:** This randomized research included 100 patients scheduled for cardiac surgery in Kasr Al-Ainy Hospital, Cairo University & Fayoum University Hospital, Department of Cardiothoracic Surgery between March 2022 and September 2022. Studied cases were separated into 2 groups; each group included fifty studied cases, the posterior pericardiotomy group (group A) and control group (group B). Postoperative evaluations were made after five & thirty days and contained electrocardiographic research, chest x-ray, & echocardiography.

**Results:** Early pericardial effusion developed in 4 studied cases (8%) in group A & 19 studied cases (38%) in group B (P<0.0001). No late pericardial effusion in group A compared to nine (18%) cases had late pericardial effusion in group B (P=0.002). Atrial fibrillation developed in 8 patients (16%) in group (A) & in 11 patients (22%) in group B (P=0.444).

**Conclusion:** Posterior pericardiotomy is safe method that significantly decreases the incidence of early & late postoperative pericardial effusion and tamponade, but it has no significant effect in reduction of postoperative AF.

**Keywords:** Atrial fibrillation, Posterior pericardiotomy, Pericardial effusion, Cardiac surgery.

## INTRODUCTION

Pericardial effusion (PE) is a problem after open heart surgery; it can progress to cause pericardial tamponade (PT), which may be fatal. Also, postoperative pericardial effusion can cause supraventricular arrhythmia & hemodynamic instability. After surgery, studied cases lie in the supine site and this can easily lead to the accumulation of fluid in the posterior pericardial space [(1)].

Postoperative atrial fibrillation (POAF) is the commonest type of arrhythmia after heart surgery with an incidence rate of twenty forty percent. POAF has been related to cardiac failure, stroke, and systemic embolism. Its recognition necessitates additional therapy with various mixtures of drugs to achieve heart rate control, and anticoagulation. Also, electrical cardioversion may be needed. Each of these methods have side effects that may worsen the outcomes. As result, POAF prolongs the duration of hospital stays & rises hospital cost [(2)].

The traditional method of draining the pericardial cavity and mediastinum, with 1 chest drain placed along the right atrium & another placed retrosternal in the anterior mediastinum, is not able to reach the posterior space. Other trials have also failed when tried to aspirate posterior effusion by percutaneous pericardiocentesis [(3)]. It was suggested that left posterior pericardiotomy (PP), simple process, allows pericardial collection to be drained into left pleural cavity thereby decreasing incidence of pericardial collection and POAF after cardiac surgery [(4)].

In our study, the primary goal was to evaluate efficiency of posterior pericardiotomy method in stopping occurrence of early & late pericardial effusion, pericardial tamponade & POAF.

## PATIENTS AND TECHNIQUES

This research was a comparative prospective study to evaluate efficiency of posterior pericardiotomy in decreasing occurrence of early, late postoperative pericardial effusion & postoperative atrial fibrillation.

The study was conducted at Kasr Al-Ainy Hospital, Cairo University & Fayoum University Hospital during the period from March 2022 till September 2022 and included 100 Adult studied cases undergoing coronary & valve surgery.

**Inclusion criteria:** Adults between 18 and 70 years old, male and female patients and patients undergoing coronary and/or valve surgery for the first time.

**Exclusion criteria:** Known history of atrial fibrillation before surgery, thyroid function abnormalities, redo cardiac surgery and aortic surgery cases, presence of adhesions in the pericardial cavity, pericardial effusion with more than five mm separation of pericardial layers, patients with bleeding tendency for example, hemophilia, any active inflammatory disease at duration of surgery and history of anti-arrhythmic drugs intake.

Patients **were** classified into two groups. Group (A) (PP Group) contained 50 patients in whom posterior pericardiotomy technique were performed. Group (B) (control group) included 50 patients with no posterior pericardiotomy technique in their operations.



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**Primary outcome:** POAF and that can be detected by rhythm monitoring or standard twelve-lead electrocardiogram. Significant pericardial effusion detected by postoperative echocardiography.
**Secondary outcome:** The incidence of reopening for bleeding & cardiac tamponade, length of ICU& hospital stay & left-sided pleural effusion as problem of this process.

**Preoperative assessment & preparation:** History taking **(**age, sex, presence of diabetes, HTN, previous history of arrhythmia, history of anti-arrhythmic drug intake and dyspnea).

**Clinical examination:** Detailed clinical examination was done including vital data (blood pressure, pulse and respiratory rate). General and local chest and cardiac examination to delineate the presence of signs of heart failure, and any heart rate irregularities.

**Laboratory investigations:** To assess the preoperative function of different body systems including complete blood count, liver function examinations (ALT, AST, bilirubin, albumin), kidney function examinations (Urea & creatinine), serum electrolytes and coagulation profile (prothrombin time, concentration and INR).
**Electrocardiogram (ECG):** 12 leads ECG and long strip ECG were done to detect any arrhythmias or evaluate any previous myocardial infarction.
**Chest x-rays:** Postero-anterior view in the erect position to evaluate cardiothoracic ratio and different cardiac chambers.

**Echocardiography:** Transthoracic echo was done for all patients to detect LA dimension, LV dimensions, EF, RWMA and any pericardial collection or adhesions.
**Coronary angiography:** To detect diseased coronary arteries in ischemic patients, in males older than 40 years old and in female patients older than 45 years old.

**Intraoperative data:** Anesthetic treatment & surgical methods were similar in both groups. With studied case in supine position, full median sternotomy was done. skeletonized or pedicled left internal mammary artery (LIMA) was harvested in situ. Saphenous venous grafts were taken in CABG patients. Opening of the pericardium, aorto-common atrial cannulation in CABG patients, and aorto-bicaval cannulation in valve replacement cases were done for connecting cardiopulmonary bypass lines. Cardioplegia cannula was secured in the ascending aorta and Cardiopulmonary bypass was initiated. When total cardio-pulmonary bypass was reached, aortic cross clamp was placed. Under mild hypothermia myocardial protection, standard bypass management comprised membrane oxygenators, non-pulsatile flow of 2.4 to 4.5 L/min per $m^2$ & mean arterial blood pressure higher than 60 mm Hg.

**Surgical technique of posterior pericardiotomy:**
In Group (A), under cardiopulmonary bypass longitudinal incision, four cm long & two cm wide, broadening from left inferior pulmonary vein to diaphragm, was made parallel & posterior to left phrenic nerve. Incision connects pericardial and pleural spaces. In Group (B), no posterior pericardiotomy was done. Weaning off cardiopulmonary bypass respecting the indication for supportive drug treatment or insertion of intra-aortic balloon pump. In both groups, three chest tubes were inserted, & pericardium was left open anteriorly. To prevent mechanical heart irritation, no retrocardiac tubes were implanted. At end of cardiopulmonary bypass, heparin was inverted by protamine sulphate (1:1). Every 60 minutes after routine chest closure & in ICU, amount of blood drainage was measured & recorded. When drainage became less than one hundred cc/24h on any day after operation, chest tubes were removed. No patients received prophylactic anti-arrhythmic drugs after surgery.

**The following operative data were collected in all patients:** Cardiopulmonary bypass duration in minutes, aortic cross clamp duration: this is the ischemic time recorded from applying the aortic clamp until removal of the clamp in minutes, weaning of CPB and need for DC shock during weaning, need for any intraoperative inotropic support and need for IABP support to aid the hemodynamic status.

**Postoperative Data:** All patients were evaluated during ICU stay, one week and 1 month postoperative.
**Intensive care unit evaluation:** Hemodynamics: Blood pressure monitoring through an arterial line, heart rate monitoring through multi-leads monitors, urine output monitoring on an hourly basis, inotropic supports, postoperative blood loss in chest tubes till removal (when 24 h drainage was less than 100 cm), blood transfusion and re-exploration for excessive blood loss, electrocardiogram (ECG) and total intensive care unit and hospital stay in days.

**One week evaluation:** Patients were evaluated one week after surgery by the following: Electrocardiogram to detect any postoperative arrhythmia, chest x-ray (Postero-anterior view to detect postoperative pleural effusion) and 2D echocardiography was completed one week postoperative to evaluate occurrence of any pericardial effusion. Any effusion > 1 cm is considered significant in our study.

**1 month evaluation:** Patients were evaluated 1 month after surgery by the following:
Electrocardiogram to detect any arrhythmia. Echocardiography to detect late effusions and tamponade.

**Ethical Approval: The research was approved by Ethics Boards of Cairo University's Kasr Al-Ainy Hospital & Fayoum University Hospital. Each participant provided informed written consent. This**

**work was done in accordance with World Medical Association's Code of Ethics for human research.**

***Statistical analysis***

SPSS version 26.0 was used to analyse data on an IBM compatible computer (SPSS Inc., Chicago, IL, USA). Qualitative data were expressed in terms of numbers & percentages, & it was analysed using Chi square test & Fisher's exact test.

The Shapiro Wilks test was used to check for normality in quantitative data, assuming normality at P > 0.05. Quantitative data were characterised as mean & standard deviation using the Student's "t" test if normally distributed, or the Mann Whitney U test if not. In this study, accepted level of significance was set at 0.05.

**RESULTS**

This research was conducted on 100 adult studied cases undergoing coronary & valve surgery: 50 in intervention group, & 50 controls. Years old of group A studied cases varied from 34 – 67 years, with mean of 52.7 ± 9.3 and for group B patients, their years old ranged from 38 – 67, with mean of 54.1 ± 7.6 years. Group A included 35 males (70%) and 15 females (30 %), while group B included 34 males (68%) and 16 females (32 %). 18 cases in group A (36%) were smokers, and group B included 20 smokers (40%).

15 patients in group A (30%) were diabetics, while group B included 16 diabetics (32%). 17 studied cases in group A (34%) had hypertension and group B included 18 hypertensive patients (36%). There was no variation among both groups regarding age, gender, smoking, DM, or hypertension (Table 1).

**Table 1:** Comparison of sociodemographic and baseline clinical characteristics between both groups (N= one hundred)

| | | Group A (PP) **(n=fifty)** | Group B **(n=fifty)** | P value |
|---|---|---|---|---|
| **Age (Years)** | Mean ± SD | 52.7 ± 9.3 | 54.1 ± 7.6 | 0.560 |
| **Gender** | Male<br>Female | 35 (70 %)<br>15 (30 %) | 34 (68 %)<br>16 (32 %) | 0.829 |
| **DM** | Yes<br>No | 15 (30 %)<br>35 (70 %) | 16 (32 %)<br>34 (68 %) | 0.829 |
| **Hypertension** | Yes<br>No | 17 (34 %)<br>33 (66 %) | 18 (64 %)<br>32 (36 %) | 0.834 |
| **Smoking** | Yes<br>No | 18 (36 %)<br>32 (64 %) | 20 (40 %)<br>30 (60 %) | 0.680 |

Regarding preoperative echocardiographic data, the mean value of LVEF (%) was 56.3 ± 4.6 and 54.4 ± 4.8 in group A & group B respectively. While mean value of LA size (cm) was 3.8 ± 0.3 and 4.0 ± 0.2 in groups A & B respectively. There was no variation between both groups regarding LVEF or LA size (figure 1).

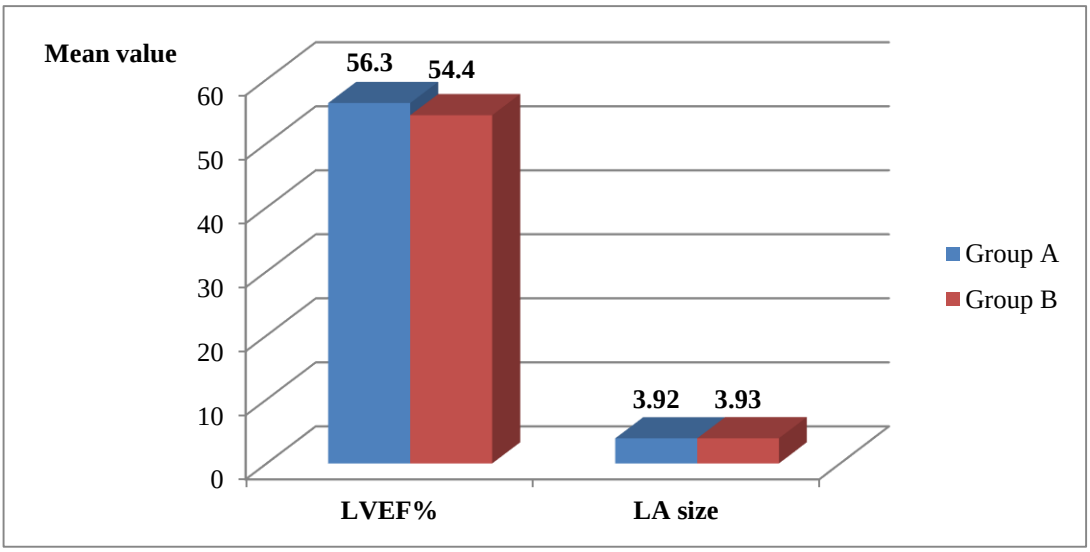


**Figure (1):** Bar chart displaying the mean value of LVEF and LA size in both groups.

Regarding surgical related data of group A. 60% of the included patients in group A underwent CABG surgery, while the least operation in frequency was DVR (2%). The mean value of CBP time was 137.8 ± 20.5 and 103.1 ± 20.0 for the cross-lamp time. 18% needed DC shock, and 50% took inotropes, and the mean value of ICT drainage was 525 ± 187.2. Regarding surgical related data of group B, 60% of the included patients in group B underwent CABG surgery, while the least operation in frequency was DVR (6%). The mean value of CBP time was 138.8 ± 20 and 105.4 ± 17.3 for the cross-lamp time. 22% needed DC shock, and 52% took inotropes, and the mean value of ICT drainage was 583 ± 225.3. There is no variation between both groups regarding any surgical related variable (Table 2).

**Table (2):** Comparison of surgery-related data between both groups (N= one hundred)

| | | Group A **(n=fifty)** | Group B **(n=fifty)** | P value |
|---|---|---|---|---|
| **Type of operation** | MVR<br>CABG<br>MVR + CABG<br>AVR<br>DVR | 13 (26 %)<br>30 (60 %)<br>2 (4 %)<br>4 (8 %)<br>1 (2 %) | 11 (22 %)<br>30 (60 %)<br>0<br>6 (12 %)<br>3 (6 %) | 0.468 |
| **CBP time (min.)** | Mean ± SD | 137.8 ± 20.5 | 138.8 ± 20 | 0.809 |
| **Cross lamp time (min.)** | Mean ± SD | 103.1 ± 20 | 105.3 ± 17.3 | 0.555 |
| **Need of DC shock** | Yes<br>No | 9 (18 %)<br>41 (82 %) | 11 (22 %)<br>39 (78 %) | 0.617 |
| **Inotropes** | Yes<br>No | 25 (50 %)<br>25 (50 %) | 26 (52 %)<br>24 (48 %) | 0.841 |
| **ICT drainage (ml)** | Mean ± SD | 525 ± 187.2 | 583 ± 225.3 | 0.091 |

Regarding post-operative data of group A, 4% of the included patients in group A needed re-opening, while 8% had pleural effusion. The mean value of length of hospital stay was 7.5 ± 1.0 and 2.3 ± 0.7 for ICU stay (days). The frequency of tamponade was zero. In group B, 6% of the included patients in group B needed re-opening, while 12% had pleural effusion. The mean value of length of hospital stay was 7.9 ± 1.2 and 2.4 ± 0.8 for ICU stay (days). The frequency of tamponade was 4%. There was no variation among both groups concerning post-operative data (Table 3).

**Table 3:** Comparison of post-operative data between both groups (N= one hundred)

| | | Group A **(n=fifty)** | Group B**(n=fifty)** | P value |
|---|---|---|---|---|
| **Tamponade** | Yes<br>No | 0<br>50 (100 %) | 2 (4 %)<br>48 (96 %) | 0.153 |
| **Re-opening** | Yes<br>No | 2 (4 %)<br>48 (96 %) | 3 (6 %)<br>47 (94 %) | 0.646 |
| **Pleural effusion** | Yes<br>No | 6 (8 %)<br>44 (92 %) | 4 (12 %)<br>46 (92 %) | 0.505 |
| **Hospital stay (days)** | Mean ± SD | 7.5 ± 1.0 | 7.9 ± 1.2 | 0.560 |
| **ICU stay (days)** | Mean ± SD | 2.3 ± 0.7 | 2.4 ± 0.8 | 0.087 |

Regarding post-operative AF incidence in group A, 16% of the included patients in group A had post-operative AF. It started after 2 days in 50% of them. While only 2% had AF on discharge. Regarding post-operative AF incidence in group B, 22% of the included patients in group B had post-operative AF. It started after 2 days in 63.6% of them. While only 4% had AF on discharge. There is no variation among both groups regarding AF incidence after the surgery (Figure 2).

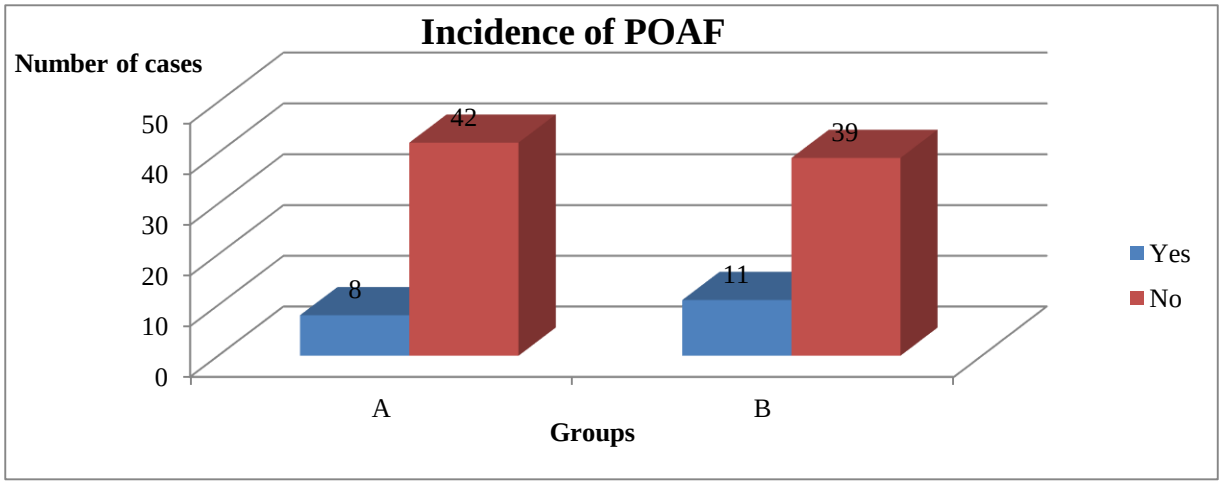


**Figure (2):** Bar chart displaying the incidence of POAF in both groups (N=100)

Regarding post-operative pericardial effusion incidence in groups A and B, early PE (after 5 days) occurred in 8% of group A & 38% of group B studied cases. While late PE (after 30 days) occurred in 18% of group B patients and didn't occur in group A. Both early & late PE were higher in group B, p value < 0.0001 and 0.002 respectively (Table 4 and figure 3).

**Table 4:** Comparison between postoperative PE incidence between both groups (N= one hundred)

| | | Group A **(n=fifty)** | Group B **(n=fifty)** | P value |
|---|---|---|---|---|
| **Early PE (5 days)** | Yes<br>No | 4 (8 %)<br>46 (92 %) | 19 (38 %)<br>31 (62 %) | **< 0.0001*** |
| **Late PE (30 days)** | Yes<br>No | 0<br>50 (100 %) | 9 (18 %)<br>41 (82 %) | **0.002*** |

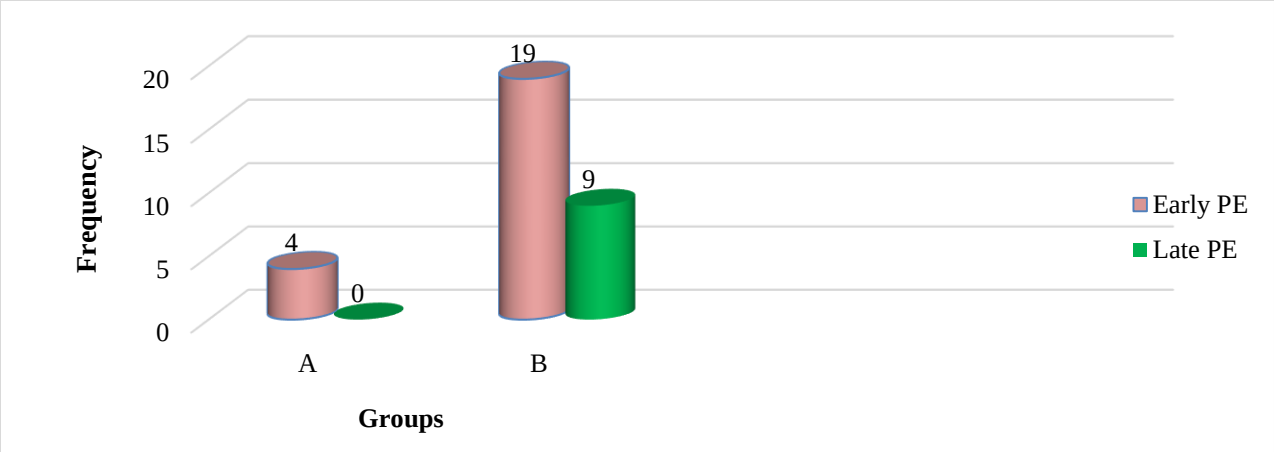


**Figure 3:** Bar chart displaying occurrence of pericardial effusion in both groups (N=100).

## DISCUSSION

There are still multiple well-known potential complications like arrhythmia, pericardial effusion & tamponade that occur after cardiac surgery. Because of postoperative bleeding or post-pericardiotomy syndrome, pericardial effusion & its problems are common after all types of cardiac surgery. Like any surgical process, posterior pericardiotomy has the potential for problems. In addition to risks related any cardiac surgery, posterior pericardiotomy is linked to higher risk of phrenic nerve injury, cardiac herniation, & longer time to drain left-sided pleural effusion [(5)].

In our study, we tried to assess effect of posterior pericardiotomy in prevention of postoperative pericardial effusion & POAF. Preoperative profile of both patient groups was similar with no statistically significant difference in demographics, risk factors, clinical examination and preoperative investigations (labs, CXR, echo variables and coronary angiography findings). This agrees with most studies done as **Kaygin *et al.*** [(6)], **Fawzy *et al.*** [(7)], **Kaya *et al.*** [(8)] and **Ekim *et al.*** [(9)].

Regarding intraoperative data in our study, the mean aortic cross clamp duration & cardiopulmonary bypass duration in group A was 103.1 ± 20 minutes and 137.8 ± 20.5 minutes and in group B, it was 105.3 ± 17.3 minutes and 138.8 ± 20 minutes respectively with no statistically significant difference, which is the same as **Fawzy *et al.*** [(7)], **Ekim *et al.*** [(9)], **Kaygin *et al.*** [(6)] and **kaya *et al.*** [(8)] who had no variation among their compared groups concerning cross clamp time & CPB time.

The number of studied cases who needed inotropic support was 25 (50%) studied cases in group A & 26 (52%) studied cases in group B with no statistically variation among the 2 groups. Also, **Fawzy *et al.*** [(7)] & **Ekim *et al.*** [(9)] described that there was no statistically variation among their two groups concerning need for inotropic support.

In our study, 100 adult studied cases undergoing coronary & valve surgery with 50 patients or without 50 patients posterior pericardiotomy technique were studied, occurrence of AF in our research was not statistically different between 2 groups, AF took place in 8 studied cases (16%) in PP group & 11 studied cases (22%) in control group (p=0.444). As a result, PP group's AF prevalence is not lower. However, our study showed that early & late pericardial effusion was less frequent in PP group (4, 0 patients) compared to (19, 9 patients) in control group (p=0.0001, 0.002) respectively. 2 patients (4%) developed tamponade in conventional group and 3 patients needed reopening, while no patient in the PP group developed tamponade, but two cases of reopening for high drainage, which is nearly the same in **Fawzy *et al.*** [(7)] (0 vs. 3%) and **Kaygin *et al.*** [(6)] (0 vs. 1.5). **Asimakopoulos *et al.*** [(10)] have proved that posterior pericardiotomy was effective in reducing incidence of postoperative pericardial effusion. However they found that POAF incidence was not decreased (20%) with posterior pericardiotomy compared to conventional techniques (26%). Another study included cases who were receiving beta blockers, which could be the cause of the decreased POAF incidence in study groups [[5]]. In our research, studied cases who were receiving beta

blockers were excluded. However, POAF incidence was not variance among the 2 groups of the study. **Mulay *et al.*** [11] have found decrease in occurrence of both postoperative pericardial effusion and related supraventricular arrhythmias with posterior pericardiotomy group compared to the control group (8 vs. 40%) (P =0.001) and concluded that posterior pericardiotomy is effective in reducing the incidence of pericardial effusions and SVT. Also, **Farsak *et al.*** [12] reported a decrease in the incidence of early (1 vs. 54%), late (0 vs. 21%) postoperative pericardial effusion and POAF (6 vs. 34%) with a posterior pericardiotomy technique in comparison with control group. Similarly, a study by **Fawzy *et al.*** [7] found that posterior pericardiotomy technique decreased POAF incidence (13 vs. 30%) and significantly decreased the pericardial effusion in posterior pericardiotomy group compared to control group (15 vs 53%).

Regarding ICU stay & hospital stay, there was no significant variation among the 2 groups concerning ICU stay (2.3 ± 0.7 in intervention group vs. 2.4 ± 0.8 in control group, P=0.087). Also, variation among the 2 groups in duration of hospital stay was insignificant (7.5 ± 1.0 vs. 7.9 ± 1.2, P= 0.560). These outcomes are nearly like that of **Farsak *et al.*** [12] and **Fawzy *et al.*** [7] who reported no significant difference in hospital stay in their compared groups.

On the other side, **Kaya *et al.*** [8] found that duration of hospital stay was lower in intervention group (6.63 ± 2.71 vs. 11.56 ± 10.64, p = 0.03). Also **kaygin *et al.*** [6] proved that posterior pericardiotomy significantly decreases duration of ICU & hospital stay (P=0.012) as these studied cases had less rhythmic complications & pericardial effusion. Many studies proved that posterior pericardial drainage is effective in shortening the duration of ICU and hospital stay [13]. But some studies, including our research, did not show variation in these parameters among intervention and control groups.

We had no postoperative problems as a result of posterior pericardiotomy incision, but it is not without risks. A serious case, which required re-operation was reported by **Yorgancioglu *et al.*** [14] where they reported that the case developed lateral ST elevation and ventricular fibrillation (VF) immediately after CABG operation with no response to defibrillation. The patient was re-operated because a segment of SVG protruded and was squeezed by edges of posterior pericardiotomy incision. Although the authors couldn't surely conclude that posterior pericardiotomy was the cause of graft obstruction, they decided to terminate the study to avoid possible risks of this technique. [15]

Limits of research included small sample size & being limited institution study. Other studies with a larger number of patients from various institutions may give more conclusive results.

## CONCLUSION

Posterior pericardiotomy is safe method which is easy to perform without obvious complications and represents an effective method that decreased incidence of early & late postoperative pericardial effusion and tamponade, but it has no significant effect in reduction of postoperative AF. Further study focusing on exact mechanisms of POAF pathogenesis is needed to understand this problem & find more effective prophylactic & therapy options.

## DECLARATIONS

- **Consent for Publication:** All authors have agreed to submit manuscript.
- **Availability of data & material:** Available
- **Competing interests:** None
- **Funding:** No fund
- **Conflicts of Interest:** Authors confirm that they had no conflicts of interest with regard to publication of this paper.

## REFERENCES


1. **Cakalagaoglu C, Koksal C, Baysal A *et al.* (2012):** The use of posterior pericardiotomy technique to prevent postoperative pericardial effusion in cardiac surgery, Heart Surg. Forum, 15: 345-365. https://doi.org/10.1532/HSF98.20111128.
2. **Abouarab A, Leonard J, Ohmes L *et al.* (2017):** Gaudino, Posterior Left pericardiotomy for the prevention of postoperative atrial fibrillation after Cardiac Surgery (PALACS): Study protocol for a randomized controlled trial, Trials, 18: 1–10. https://doi.org/10.1186/s13063-017-2334-4.
3. **Zhao J, Cheng Z, Quan X *et al.* (2014):** Does posterior pericardial window technique prevent pericardial tamponade after cardiac surgery?, J. Int. Med. Res., 42: 416–426. https://doi.org/10.1177/0300060513515436.
4. **Ali-Hassan-Sayegh S, Mirhosseini S, Liakopoulos O *et al.* (2015):** Vahabzadeh, M. Aghabagheri, M.R. Mozayan, A.F. Popov, Posterior pericardiotomy in cardiac surgery: Systematic review and meta-analysis, Asian Cardiovasc. Thorac. Ann., 23: 354–362. https://doi.org/10.1177/0218492314541132.
5. **Dallan L, Jatene F (2013)**. Myocardial revascularization in the XXI century. Brazilian Journal of Cardiovascular Surgery, 28:137-144.
6. **Kaygin M, Dağ Ö, Güneş M *et al.* (2011):** Posterior pericardiotomy reduces the incidence of atrial fibrillation, pericardial effusion, and length of stay in hospital after coronary artery bypasses surgery, Tohoku J. Exp. Med., 225: 103–108. https://doi.org/10.1620/tjem.225.103.
7. **Fawzy H, Elatafy E, Elkassas M *et al.* (2015):** Can posterior pericardiotomy reduce the incidence of postoperative atrial fibrillation after coronary artery bypass grafting?, Interact. Cardiovasc. Thorac. Surg., 21: 488–491. https://doi.org/10.1093/icvts/ivv190.
8. **Kaya M, Utkusavaś A, Erkanli K *et al.* (2016):** The Preventive Effects of Posterior Pericardiotomy with Intrapericardial Tube on the Development of Pericardial

Effusion, Atrial Fibrillation, and Acute Kidney Injury after Coronary Artery Surgery: A Prospective, Randomized, Controlled Trial, Thorac. Cardiovasc. Surg., 64: 217–224. https://doi.org/10.1055/s-0035-1548737.

9. **Ekim H, Kutay V, Hazar A *et al.* (2006):** Effects of posterior pericardiotomy on the incidence of pericardial effusion and atrial fibrillation after coronary revascularization, Med. Sci. Monit., 12: 345-359
10. **Asimakopoulos O, Della-Santa R, Taggart D (1997):** Effects of posterior pericardiotomy on the incidence of atrial fibrillation and chest drainage after coronary revascularization: a prospective randomized trial. J Thorac Cardiovasc Surg., 113: 797–9.
11. **Mulay J, Kirk A, Angelini G *et al.* (1995):** HUTTER, Posterior pericardiotomy reduces the incidence of supra-ventricular arrhythmias following coronary artery bypass surgery, Eur. J. Cardio-Thoracic Surgery, 9: 645-660
12. **Farsak B, Günaydin S, Tokmakolu H *et al.* (2002):** Zorlutuna, Posterior pericardiotomy reduces the incidence of supra-ventricular arrhythmias and pericardial effusion after coronary artery bypass grafting, Eur. J. Cardio-Thoracic Surg., 22: 278–281. https://doi.org/10.1016/S1010-7940
13. **Benyameen B, Elgariah M, Sallam A *et al.* (2020):** A study of posterior pericardial drainage in adult cardiac surgery, Tanta Med. J, 48: 159. https://doi.org/10.4103/tmj.tmj_54_21.
14. **Yorgancioğlu C, Farsak B, Tokmakoğlu H *et al.* (2000):** An unusual experience with posterior pericardiotomy [1] (multiple letters), Eur. J. Cardio-Thoracic Surg., 18: 727–728. https://doi.org/10.1016/S1010-7940 (00)00586-8.
15. **Kongmalai P, Karunasumetta C, Kuptarnond C *et al.* (2014):** The posterior pericardiotomy. Does it reduce the incidence of postoperative atrial fibrillation after coronary artery bypass grafting?, J. Med. Assoc. Thail., 97: S97–S104.