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The Preventive Role of Posterior Pericardial Window in the Complications Following Coronary Artery Bypass Grafting

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ABSTRACT

Background: Open-heart surgeries are considered complex procedures because of their high potential risks and postoperative complications. The complications of coronary artery bypass grafting (CABG) surgery remain a burden resulting in morbidity, mortality, and decreased quality of life (QoL).

Objective: This research objected to assessing the preventive role of posterior pericardial window (PPW) in the complications following CABG.

Methods: This prospective randomized case-controlled clinical research involved 100 patients who underwent CABG. Patients were equally distributed into two groups: Group A (n=50): in which a PPW was performed and Group B (n=50): the control group in which the pericardium was not opened. Postoperative complications as atrial fibrillation (AF), pericardial and pleural effusion, tamponade, and total drainage volume were recorded.

Results: The total drainage during the 1st 24 h and the onset of postoperative atrial fibrillation (POAF) were significantly greater in group B compared to group A (P value <0.001 and 0.028 respectively). Although tamponade, re-exploration, early pericardial effusion (PE), and bibasilar atelectasis were higher in group B than group A, the difference was not significant. The ICU and hospital stay duration was significantly prolonged in group B than group A (P value <0.001).

Conclusions: The PPW procedure is simple, easy to perform and reduces the incidence of serious complications following CABG with economic efficiency concerning reducing the hospital stay duration.

Keywords: Coronary Artery Bypass Grafting, Posterior Pericardial Window, Pericardiotomy, Atrial Fibrillation, Pericardial Effusion

INTRODUCTION

Open-heart surgeries are considered complex procedures because of their high potential risks and postoperative complications [1]. Over the past few decades, coronary artery bypass grafting (CABG) has continued to be the highly frequently conducted cardiac surgery [2]. Although the safety and efficacy of CABG surgery in treating coronary artery disease (CAD) are well-established, its complications remain a burden resulting in morbidity, mortality, and decreased quality of life (QoL) [3].

Postoperative atrial fibrillation (POAF) is a highly prevalent form of secondary AF and a frequent complication of cardiac surgeries (20–40%). It is found more frequently following valve surgery or concomitant surgical procedure, particularly during the 1st two days [4]. It is accompanied with higher heart failures, cognitive alterations and cerebrovascular accident

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(CVA), infections, renal dysfunctions, and duration of hospital stay and its related costs and reduced survival [5].

Many etiological variables have been determined as contributing to the progression of POAF including age, left ventricular aneurysm, atrial dilatation, perioperative myocardial infarction, hyperthyroidism, valve surgeries, low cardiac output following surgery, respiratory complications, pericardial effusion (PE), and renal failure [6].

Postoperative PE may happen in up to 85% of patients following cardiac surgeries. It is frequently benign and small; however, it can be widespread and quite extensive, and it has the potential to obstruct cardiac filling, resulting in tamponade. The chest tubes facilitate the anterior effusions drainage; however, posterior effusions become circumscribed and loculated, resulting in mechanical irritation of the left auricle and atrial arrhythmias progression [6].

Left pericardiotomy is a simple surgical technique in which the pericardial space is drained into the left pleural cavity via a posterior pericardial incision, and this technique has been proposed to potentially decrease the POAF incidence [7].

This research objected to assessing the preventive role of posterior pericardial window (PPW) in the complications following CABG.

PATIENTS AND METHODS

In this prospective randomized case-controlled clinical study, 122 patients (≥18 years old) who underwent CABG during the period from February 2019 to September 2019 at Cairo University Hospital were assessed for eligibility, The criteria were not met by 14 patients, and 8 patients declined to be included. So, the other 100 patients were equally randomly assigned into two groups **(Figure 1)**. An informed written consent was obtained from each patient.

Exclusion criteria were previous cardiac surgery or sternotomy, paroxysmal AF, asthma, coagulation dysfunction which may have an impact on the outcomes, and renal or hepatic disorders.

Patients were assigned into two groups:

- **Group A (n=50):** in which a PPW was performed.
- **Group B (n=50):** the control group in which the pericardium was not opened.

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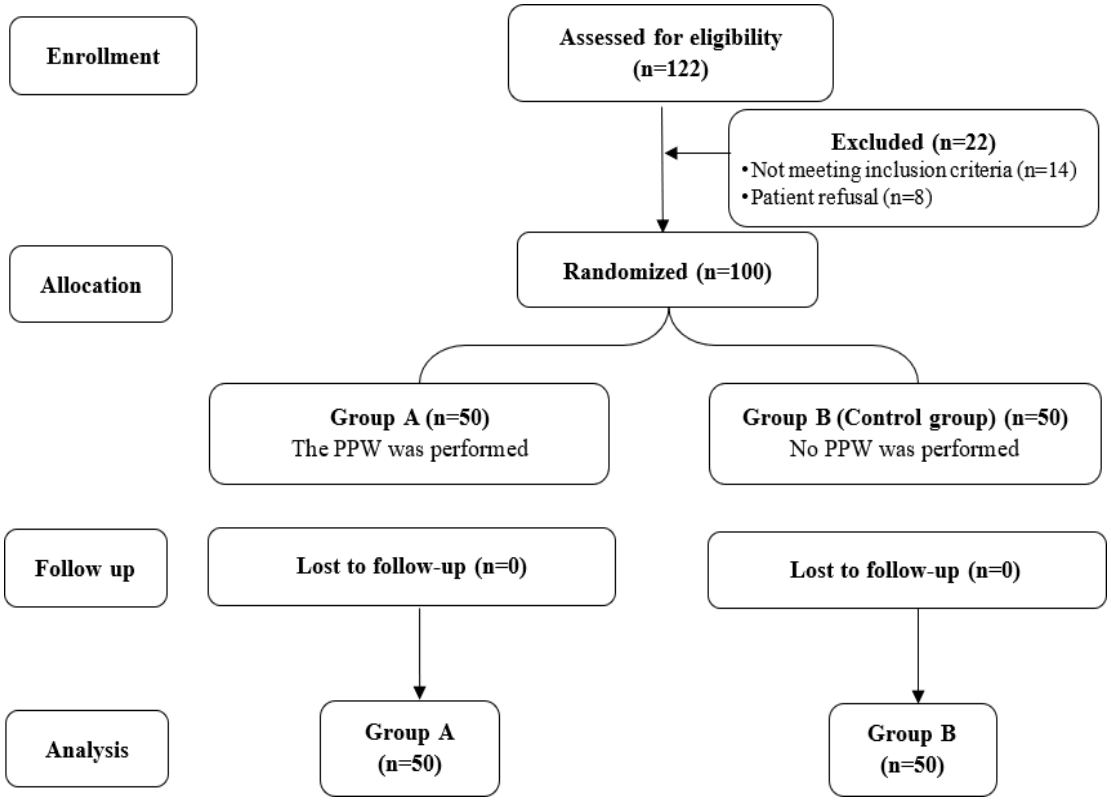

Figure (1): CONSORT flow chart

The demographic and preoperative data were collected as history taking including age, sex, and comorbid related data. Also, the surgery related data including duration of surgery and number of grafts were determined. The postoperative follow up data were recorded as incidence of postoperative cardiac tamponade, total drainage volume, incidence of PE, pleural effusion, and new-onset AF, and the length of hospital and intensive care unit (ICU) stay.

Posterior Pericardial Window (PPW) Technique:

At the first, the phrenic nerve was recognized, and an inversed T incision (2.5 cm in both dimensions) was made. Gauze was employed to protect the inflating lung. An incision in the pleural cavity using noncontinuous electrocautery was created, extending from the left inferior pulmonary vein to the diaphragm and running parallel and posterior to the phrenic nerve. Electrocautery was employed to stabilize the adipose tissue surrounding the incision, in addition to protecting the phrenic nerve.

In the anterior mediastinum, a 28 F rubber tube was inserted, and a 28 F silicone tube was inserted into the left and/or right pleural cavity, via the 7^{th} intercostal space at the left midaxillary line. A waterseal drainage device was used to connect the tubes in a distinct manner. A second 28 F silicone tube was placed if bilateral pleurae were opened. No drain was inserted retrocardially to prevent tube-induced arrhythmia. Finally, these tubes were affixed with skin with 4-0 silk sutures and wrapped with a sterilized dressing.

In the initial five postoperative days, continuous ECG monitoring was carried out. Therefore, repeated monitoring was reinstated if an arrhythmia was identified, heart rhythm alterations,

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or if there was a palpitation complaint from the patient. The POAF was diagnosed if an AF episode lasted for more than 30 minutes despite electrolyte imbalance and hypoxia.

A 2D echocardiography was conducted on the 3rd and 5th days after surgery and prior to discharge to evaluate any PEs presence. If PE exceeded 1 cm, it was regarded as significant. Furthermore, echocardiography was conducted subsequent to discharge to identify late PEs and tamponade.

Statistical analysis:

Statistical analysis was done by SPSS v26 (IBM Inc., Armonk, NY, USA). Shapiro-Wilks test and histograms were applied to assess the normality of the distribution of data. Numerical data were expressed as mean and standard deviation (SD) and were compared using unpaired student t-test. Categorical data were expressed as frequency and percentage (%) and were compared using Chi-square test or Fisher's exact test when appropriate. A two tailed P value ≤ 0.05 was considered statistically significant.

RESULTS

The mean age of the studied patients was 56.18 (± 6.44) in group A and 57.3 (± 6.4) in group B with no significant difference among the two groups. There were 40 (80%) males and 10 (20%) females in group A and 38 (76%) males and 12 (24%) females with no significant difference among the two groups **(Table 1)**.

The BSA, DM, HTN, hyperlipidemia, and preoperative ejection fraction (EF) were insignificantly different among the two studied groups **(Table 1)**.

Table (1): Patients' demographic and preoperative data

	Group A (n=50)	Group B (n=50)	P value
Age (years)	56.18 ± 6.44	57.3 ± 6.4	0.385
Males / Females	40 (80%) / 10 (20%)	38 (76%) / 12 (24%)	0.629
BSA (m^2)	1.77 ± 0.26	1.79 ± 0.18	0.641
DM	32 (64%)	35 (70%)	0.524
HTN	22 (44%)	24 (48%)	0.688
Hyperlipidemia	27 (54%)	24 (48%)	0.548
Preoperative EF (%)	51.74 ± 6.51	53.14 ± 7.65	0.327

Data are presented as mean ± SD or frequency (%), BSA: body surface area, DM: diabetes mellitus, HTN: hypertension, EF: ejection fraction.

The duration of surgery ranged from 5 to 8 h with a mean ± SD of 6.7 ± 1.2 h in group A and ranged from 5 to 7 h with a mean ± SD of 6.18 ± 0.8 h in group B with a statistically significant increase in group A (P value =0.012). The total bypass time, cross-clamp time, and number of grafts were insignificantly different among the two studied groups **(Table 2)**.

Table (2): Operative data

	Group A (n=50)	Group B (n=50)	P value
Operation duration (h)	6.7 ± 1.2	6.18 ± 0.8	0.012*
Total bypass time (min)	105.5 ± 11.6	108.76 ± 16.5	0.256
Cross-clamp time (min)	74.6 ± 8.52	72.32 ± 8.86	0.193
Number of grafts	3.1 ± 0.76	3.2 ± 0.83	0.533

Data are presented as mean ± SD, *: significant as P value ≤0.05.

The total drainage during the 1st 24 h ranged from 270 to 680 cc with a mean ± SD of 474.44 ± 130.11 cc in group A and ranged from 635 to 1110 cc with a mean ± SD of 860.32 ± 134.91 cc in group B with a statistically significant increase in group B (P value <0.001) **(Table 3)**.

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The onset of AF was significantly greater in group B (10 (20%)) compared to group A (2 (4%)) (P value =0.028). Although tamponade, re-exploration, early PE, and bibasilar atelectasis prevalence were higher in group B than group A, the difference was not significant. Also, the pleural effusion was insignificantly different among the two groups **(Table 3)**.

The ICU and hospital stay duration was significantly prolonged in group B than group A (P value <0.001) **(Table 3)**.

Table (3): Postoperative data

	Group A (n=50)	Group B (n=50)	P value
Total drainage during the 1st 24h (cc)	474.44 ± 130.11	860.32 ± 134.91	<0.001*
Tamponade	0 (0%)	2 (4%)	0.495
Re-exploration	2 (4%)	5 (10%)	0.436
Early pericardial effusion	0 (0%)	2 (4%)	0.495
Pleural effusion	2 (4%)	2 (4%)	1.000
Bibasilar atelectasis	4 (8%)	5 (10%)	1.000
Atrial fibrillation	2 (4%)	10 (20%)	0.028*
ICU stay (days)	2.92 ± 0.78	3.82 ± 1.27	<0.001*
Length of hospital stay (days)	6.36 ± 1.05	8.14 ± 1.51	<0.001*

Data are presented as mean ± SD or frequency (%), ICU: intensive care unit, *: significant as P value ≤0.05.

DISCUSSION

Left pericardiotomy is a simple surgical technique which involves the drainage of pericardial space into the left pleural cavity via a posterior pericardial incision, and this technique has been hypothesized to potentially decrease the PE, early and late tamponade, and POAF incidence [8].

In our study, there was no significant difference among PPW and control group was observed regarding demographic data (age, sex, and BSA) and comorbid data (DM, HTN, and hyperlipidemia). Also, no significant difference was found regarding the preoperative EF.

The duration of surgery was statistically significantly increased in group A (PPW group) than group B (control group) (P value =0.012) while the total bypass time, cross-clamp time, and number of grafts were insignificantly different between the two groups.

Our findings revealed that the total drainage during the 1st 24 h was statistically significantly increased in group B (control group) (mean ± SD; 860.32 ± 134.91 cc) than group A (PPW group) (mean ± SD; 474.44 ± 130.11 cc) (P value <0.001).

In agreement with our findings, Zhao et al. [9] demonstrated a significant elevated total drainage output in PPW group than control group. Other studies [10, 11] found that the total drain output including pleural drainage was insignificantly different between the pericardiotomy and control group. It is not likely that the higher drain was a consequence of pericardial incision bleeding as the edges were cauterized and carefully examined for bleeding. These findings may suggest that PP has a long-term impact by preventing the pericardium from being irritated by bleeding fluid.

The onset of AF was significantly greater in group B (10 (20%)) compared to group A (2 (4%)) (P value =0.028). Although tamponade, re-exploration, early PE, and bibasilar

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atelectasis were higher in group B than group A, the difference was not significant. Also, the pleural effusion was insignificantly different among the two groups.

In the initial three days following surgery, all AFs were identified. It is probable that the patients who underwent PPW interventions experienced a lower incidence of POAF attacks due to the mechanical irritation caused by reduced PE. One of the potential causes of POAF is the mechanical irritation of bleeding fluid.

These results supported by Sadeghpour et al. [12] who found that among 40 cases in control group 18 experienced early PEs versus 2 patients in pericardiotomy group. Also 57% of control group patients experienced late PEs Vs 10% in pericardiotomy group with a significant difference among the two groups regarding both early and late PE and Zhao et al. [9] who demonstrated a significantly lower incidence of pericardial tamponade, small and moderate-to-large PE after drainage extubation, and POAF in the PPW group compared to the control group.

In Fawzy et al. [6] research, POAF were significantly less prevalent in the PPW group. The POAF incidence was highest on the 2nd postoperative day, with all cases occurring within the first five days following the operation. Additionally, the presence of PE was significantly more frequently associated with POAF. The total pleural drainage and the duration of drainage were significantly greater in the PPW group. There was a significant elevation in postoperative PE in pericardiotomy group. Tamponade developed in 3 patients in control group while no patients in pericardiotomy group developed tamponade.

This can be advantageous for both the patient and the surgeon in the way that it eliminates the need for an emergent re-opening in the ICU and allows for a more controlled reopening and exploration in the operation room, reducing sternal wound complications and their related morbidity and mortality which makes it an ideal technique and antiseptic environment.

The incidence of tamponade was reduced by the PPW technique; however, it was not entirely prevented, particularly in active hemorrhage patients. We believe that the PPW procedure may be highly appropriate for those with coagulation diseases. This is due to the effusion could be promptly evacuated into a larger pleural cavity, which reduces the rapid accumulation of intrapericardial fluids and a substantial elevation in heart pressure.

Also, Kaya et al. [13] found the reoperation due to tamponade was significantly higher in the control group. PE exhibited a significant regression in the pericardiotomy group on postoperative day 30. A higher rate of POAF was noted in the pericardiotomy group, but the difference was not significant while [14] revealed that POAF was significantly decreased in patients with totally closed pericardium (8.57%) than those with partially closed pericardium (27.78%). Also, the small PE lower prevalence in the patients group during the 2nd day of postoperative care was statistically significant.

Kaygin et al. [15] demonstrated a significantly higher POAF, early and late PE, and tamponade occurred more frequently in control group.

For these reasons, it is crucial to perform PP to either prevent the formation of hematomas or evacuate the fluid from intrapericardial spaces, with a particular emphasis on the posterior pericardium and the area surrounding the right atrium and ventricle.

The risk of PE may be elevated using anticoagulant medications in the treatment of POAF, as both PE and POAF have a detrimental impact on cardiac output. Consequently, the PE and POAF incidence and the associated adverse effects may be reduced using PP and the insertion of an intrapericardial tube [16].

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The pulmonary complications associated with PPW technique are significant factors to consider as the presence of left pleural effusions necessitating postoperative drainage. Studies demonstrated an elevated pleural effusions incidence in PPW group but there was no corresponding increase in the risk of pulmonary complications [9, 15, 17]. These findings indicated that the PPW procedure establishes an efficient drainage pathway from the pleural cavity. Fluid accumulation in the pericardium and cardiac compression may occur in the absence of this technique.

The ICU and hospital stay duration was significantly prolonged in group B compared to group A (P value <0.001).

Furthermore, PPW technique was related with decreased hospital and ICU stay duration. So, the total hospital costs were decreased in the pericardiotomy group [13-15].

In contrary, Uzun et al. [8] stated no significant difference regarding the length of hospital stay between window (mean ± SD; 6.48 ± 4.17) and non-window (mean ± SD; 7.02 ± 2.3) group. Although the duration of stay was decreased in window group, but that difference was not significant.

The control group patients exhibited a higher incidence of pleural effusion and atelectasis. The extended hospitalization duration of patients, particularly those with POAF and PE, may have been the result of any of these factors, necessitating close echocardiographic monitoring.

Limitations: the relatively small sample size and the single center study. So, ideally a multicentered study with a greater proportion of patients would undoubtedly be highly beneficial and would provide more robust findings, however, our findings are in line with previous studies. The duration of patient follow-up was relatively short. The study's ability to identify correlations with other baseline patient characteristics is restricted.

CONCLUSIONS

The PPW procedure is simple, easy to perform and reduces the incidence of serious complications following CABG with economic efficiency concerning reducing the hospital stay duration. The procedure is beneficial in reducing the pericardial tamponade and effusion-related AF incidence, so it’s advisable especially with marked effusion due to coagulation dysfunction.

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Conflict of Interest: Nil

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