The Egyptian Cardiothoracic Surgeon

In Press

Original Article

The value of pericardial window in preventing pericardial effusion after cardiac surgery

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Abstract

Background: Pericardial window (PW) is a technique that allows the passage of fluid from the pericardial to the pleural cavity to reduce the postoperative pericardial effusion. The purpose of this study was to evaluate the effectiveness of the pericardial window in decreasing pericardial effusions after cardiac surgery.

Methods: The study included 400 adult patients who underwent cardiac surgery from 2017 to 2020. Patients were randomly assigned into two groups; the pericardial window (PW) group included 200 patients who underwent posterior pericardiotomy, and the control group included 200 patients who did not undergo this procedure.

Results: Preoperative data were comparable between both groups. More patients in the PW group had chest tube drainage more than 500 cc/ 24 hours (40 (20%) vs. 5 (2.5%), respectively; p=0.005). The drainage of 500 cc/24 hours or more in the mediastinal tube was lower in the PW group (10 (5%) vs. 40 (20%) patients in the PW and control groups, respectively; p<0.001). Early pericardial collection occurred in 6 patients in the PW group (3%) vs. 46 (23%) in the control group (p<0.001), and no patient had late effusion in the PW group vs. 26 (13%) in the control group (p< 0.001). Six patients in the PW group (3%) had postoperative atrial fibrillation and 12 patients (6%) in the control group (p= 0.23). Pulmonary complications were nonsignificantly higher in the PW group (Lung collapse: 40 (20%) vs. 26 (13%); p=0.08 and pleural effusion: 34 (17%) vs. 26 (13%); p= 0.3, in the PW vs. control groups, respectively).

Conclusion: Posterior pericardiotomy is a simple technique that could reduce postoperative pericardial effusion, atrial fibrillation, and the pericardial tamponade. The technique did not increase the postoperative complications compared to the standard method.

KEYWORDS
Pericardial window; Pericardial effusion; Posterior pericardiotomy

Introduction

Pericardial effusion is a common postoperative complication after cardiac surgery, which increases the hospital stay and associated cost [1]. Most effusions are small and asymptomatic, with a reported rate reaching up to 84% [2].

Posterior effusions are not well-drained with mediastinal and pleural drains [3]. Early cardiac

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tamponade after open-heart surgery is usually caused by surgical bleeding or coagulopathy, while late tamponade is a multifactorial in origin [4,5]. Echocardiography is the gold standard diagnostic method for detecting postoperative pericardial effusions [6].

The pericardial window is a strategy that permits the passage of fluid from the constrained pericardial cavity to the bigger pleural spaces to prevent pericardial effusion [3,7]. In several studies, the pericardial window decreased the frequency of atrial fibrillation, wound infection, and hospital stay [8,9]. The objective of the present study was to assess the efficacy of pericardial window technique in preventing postoperative tamponade and effusion-related complications after cardiac surgery.

Patients and Methods:

Design and patients:

This research is a randomized controlled trial design conducted between January 2017 and January 2020. This study was approved by our Institutional Ethics Committee, and all patients provided written informed consent before participation (Clinical trial registration number: RC-3-6-2016).

The study included 400 patients who underwent valvular or coronary artery bypass grafting surgery. We randomly assigned the patients into two groups: patients who underwent the posterior pericardiotomy technique (PW group; n = 200) and patients who did have posterior pericardiectomy (control group; n = 200).

In the PW group, the posterior pericardiotomy technique (PP) was made by a 4 cm longitudinal incision parallel and posterior to the left phrenic nerve, extending from the left inferior pulmonary vein to the diaphragm prior to discontinuation of the cardiopulmonary bypass as described by Mulay and coworkers [10]. In the control group, the left pleura was opened, but we did not perform a pericardial window.

We excluded patients who underwent re-operative surgery, patients with hepatic or renal dysfunction, and who had preoperative coagulation disorders.

Data collection:

For all patients, we recorded the demographic data (age, gender, body mass index, hypertension, and diabetes mellitus), and operative data (cardiopulmonary bypass and cross-clamp time). Study outcomes were total drainage volume, pleural effusion, pericardial effusion, and tamponade.

According to Hein and collaborators, prolonged ICU stay was defined as more than 96 hours stay in ICU [11], prolonged hospital stay was defined according to Mazzoni and colleagues, as more than 168 hours stay in hospital including the day of discharge [12] and prolonged ventilation time was considered after 24 hours according to Gatti and coworkers [13].

Statistical analysis:

Data management and statistical analyses were performed using SPSS version 25 (IBM SPSS Statistics for Windows, version 23.0; IBM Corp., Armonk, New York, USA). Numerical data were summarized as mean and standard deviations or median and ranges. Categorical data were summarized as numbers and percentages. Comparisons between two groups were performed using independent t-test for normally distributed numerical variables or Mann-Whitney test for non-normally distributed variables. Categorical variables were compared using the Chi-square test or Fisher exact test when appropriate. All P values were two-sided. P values of less than 0.05 were considered significant.

Results

There was no significant difference in the age, sex, body mass index (BMI), comorbidities, cardiopulmonary bypass, and cross-clamp times between the PW group and the control group (Table 1).

The most common procedure in the PW and control groups was coronary artery bypass grafting, which accounted for 64% and 67% of patients, respectively, with no statistically significant difference (Table 1).

Table 1: Preoperative data. Continuous data are presented as mean and SD and categorical data as numbers and percentages.

	PW group (n=200)	Control group (n=200)	P
Age (Years)	43.4 ±6.5	44.5 ±9.6	0.18
Male	132 (66)	120 (60.0)	0.2
Weight (kg)	79.9 ±12.8	80.3 ±12.3	0.75
Height (cm)	166.8 ±8.1	167.1 ±8.5	0.72
BMI	27.8 ±4.5	28.1 ±3.2	0.44
HTN	66(33)	60 (30)	0.59
DM	94(47)	100 (50.0)	0.66
Clamp time (minutes)	50±19.4	51.4±20.6	0.48
Total bypass time (minutes)	72.4±20.9	73.5±22.7	0.61
Aortic valve	6 (3%)	14 (7%)	0.05
ASD	6 (3%)	6 (3%)	
CABG	128 (64%)	134 (67%)	
Mitral valve	20 (10%)	14 (7%)	
Mitral +Aortic	6 (3%)	14 (7%)	
Mitral+Aortic+Tricuspid	14 (7%)	6 (3%)	
Mitral+CABG	14 (7%)	6 (3%)	
Mitral + Tricuspid	6 (3%)	6 (3%)	

ASD: atrial septal defect; CABG: coronary artery bypass graft; BMI: body mass index; HTN: hypertension; DM: diabetes mellitus; PW: posterior window

The difference between the left pleural tube drainage in the two groups was highly significant (p =0.005); however, the timing of removal of the chest tube in the two groups was not significant (p= 0.1) (Table 2).

The amount of mediastinal drainage in the PW group was lower than the control group (p< 0.001) (Table 2). Six patients had an early collection with no signs of tamponade in the PW group. In comparison, in the control group, there were 46

Table 2: Chest tube drainage and timing of removal. Data are presented as numbers and percentages.

		PW group (n= 200)	Control group (n= 200)	p
Chest tube drainage (left pleura)	Low	174 (87%)	94 (47%)	0.005
	Moderate	66 (33%)	26 (13 %)	
	High	40 (20%)	5 (2.5%)	
Chest tube removal	Early	120 (60%)	106 (53%)	0.1
	Late	80 (40%)	49 (47%)	
Mediastinal tube drainage	Low	154 (77%)	100 (50%)	<0.001
	Moderate	46 (23%)	60 (30%)	
	High	10 (5%)	40 (20%)	
Mediastinal tube removal	Early	174 (87%)	98 (49%)	0.002
	Late	26 (13%)	96 (48%)	

PW: posterior window.

- Low drainage less than 100cc/24 hour
- Moderate drainage from 100cc to 500cc/24hour
- High drainage more than 500cc/24 hour

Table 3: Comparison of early and late pericardial effusion. Data are presented as numbers and percentages.

	PW group (n= 200)	Control group (n= 200)	p
Early collection in Echo	6 (3%)	46 (23%)	<0.001
Early tamponade in Echo	0	20 (10%)	<0.001
Early re-exploration	0	20 (10%)	<0.001
Late collection in Echo	6 (3%)	40 (20%)	<0.001
Late tamponade in Echo	0	26 (13%)	<0.001
Late re-exploration	0	26 (13%)	<0.001

PW: posterior window

patients with an early collection, and 32 patients from them showed signs of tamponade (Table 3). In the PW group, the patient with pericardial collection required no surgical intervention. There were 46 patients with pericardial collection in the control group; 26 of them had no surgical intervention, and 20 patients had pericardiocentesis (n= 10), subxiphoid drainage (n= 5), and re-exploration (n= 5).

There was a significant difference in the occurrence of the early collection (p <0.001) between both groups. Additionally, there was a statistically significant difference in the late postoperative collection (6 (3%) versus 40 (20%) in the PW vs. control group; p< 0.001). Twenty-six patients in the control group had late tamponade diagnosed with echocardiography (Table 3).

Pleural effusions and lung collapse were higher in the PW group but did not reach a significant level. There was no significant difference between both groups regarding deep sternal wound infection, prolonged mechanical ventilation, ICU, and hospital stay (Table 4).

There was no statistical difference between the two groups regarding the occurrence of supraventricular tachycardia (0 vs. 4 (2%) patients in the PW and control group, respectively; p =0.12) (Table 4).

Discussion

Postoperative pericardial effusion is a common complication following open-heart surgery, with an incidence ranging from 4.7% to 85% depending on the method used for its detection [14]. It is often localized posteriorly and associated with increased morbidity and mortality [14]. There are controversial reports on the role of the posterior pericardiotomy technique in preventing postoperative pericardial effusion [15, 16]. A study reported an incidence of pericardial effusion after pericardiotomy technique of 8% versus 40% in patients who had a traditional drainage method [17].

Posterior pericardiotomy acts like a safety valve that protects the patient from tamponade, early and late pericardial effusions, and decreases the incidence of arrhythmias [18].

Table 4: Postoperative complications. Data are presented as numbers and percentages.

	PW group (n= 200)	Control group (n= 200)	p
Left pleural effusion	34 (17%)	26 (13%)	0.3
Lung collapse	40 (20%)	26 (13%)	0.08
Deep sternal infection	6 (3%)	8 (4%)	0.6
Prolonged mechanical ventilation	6 (3%)	8 (4%)	0.6
Prolonged ICU stay	6 (3%)	10 (5%)	0.3
Prolonged hospital stay	6 (3%)	10 (5%)	0.3
AF	6 (3%)	12 (6%)	0.23
SVT	0	4 (2%)	0.12

AF: atrial fibrillation; SVT: supraventricular tachycardia; PW: posterior window

Late pericardial effusion and hemodynamic instability may also happen due to improper drainage [15]. Improper drainage of the pericardial fluid can lead to tamponade, and consequently, increases the mortality [19]. Many studies reported that posterior pericardiotomy could drain the pericardial fluid in the left pleural space, thereby reducing the development of pericardial effusion and eliminating the possibility of tamponade [5].

Proper drainage, placement, and patency of the drains are the key to a safe postoperative course [15]. In intensive care, the semi-sitting position helps chest drainage in the early postoperative period [20].

The slightly increased blood loss in the pericardial window group suggests that this method provides an effective pathway of drainage to the pleural cavity of pericardial blood/effusion, which otherwise would have been collected in the pericardium and compressed the heart. Pleural effusion and pulmonary complications were not significantly more frequent in the pericardial window group [21]. Posterior pericardial effusion can be evacuated by placing a tube in the posterior pericardial space [22, 23]

Echocardiographic evaluation of the control group demonstrated more posterior and lateral pericardial effusions compared to patients in the pericardial window group. Previous reports showed that patients with pericardial effusion had a higher prevalence of supraventricular arrhythmias [24].

Mulay and colleagues demonstrated reductions in both pericardial effusion and related supraventricular arrhythmias in the posterior pericardiotomy group compared with the control group [10]. We did not find a difference in supraventricular tachycardia between both groups, which could be attributed to the small number of patients who developed this complication. Another study showed that posterior pericardiotomy is a simple intraoperative technique that might increase the incidence of pericardial effusion but could reduce atrial fibrillation [25].

Few effusions can progress to become hemodynamically significant and results in cardiac tamponade [26]. The incidence of cardiac tamponade was higher in the control group than the pericardial window group. It was evident that postoperative pericardial effusion and late pericardial tamponade after cardiac surgery were more likely to be encountered in patients who require anticoagulation therapy in the postoperative period. The posterior pericardiotomy technique was a very valuable technique for preventing postoperative late pericardial tamponade in patients who undergo valve surgery [27].

Asimakopoulos and coworkers have shown that posterior pericardiotomy was more effective for pericardial drainage, but they also have shown that atrial fibrillation prevalence was not significantly reduced (20%) in comparison with the conventional technique (26%) [28]. The pericardiotomy groups have significantly higher blood loss. Still, they did not find a significant total blood loss difference between the two groups, and the pleural drainage was higher in the pericardial window group [15]. It is unlikely that increased drainage was the result of bleeding from the pericardial incision because the edges were cauterized and checked for bleeding [15].

The posterior pericardial tubes may come into contact with coronary grafts during cardiac activity or movement, so it is better to fix the pericardial tube to the surface of the diaphragmatic pericardium [20]. The posterior pericardiectomy may reduce fluid collection and its arrhythmogenic effect and, consequently, the need for anti-arrhythmic medications [25].

There might be several complications related to the posterior pericardial window technique, such as cardiac herniation. Therefore, this technique should be used carefully in patients in whom posterior wall revascularization was performed, especially by sequential grafting [29].

There is no sufficient research regarding the effects of posterior pericardiotomy on long-term results. A previous study demonstrated that patients undergoing posterior pericardiotomy had a significantly shorter hospital stay and experienced lower rates of pericardial effusion and cardiac tamponade than the control group [20].

Limitations

The study was powered to detect the difference in pericardial effusions between both groups. However, the number of patients who had postoperative arrhythmia was not enough to detect a statistical difference. The study included patients who had different surgery. This might affect the internal validity of the study but increased its external validity.

Conclusion

Posterior pericardiotomy could reduce the incidence of early pericardial effusion, atrial fibrillation, and pericardial tamponade. The technique did not increase postoperative complications.

Conflict of interest: Authors declare no conflict of interest.

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