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Influence of Posterior Pericardiotomy on Early and Late Pericardial Effusions Post CABG

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ABSTRACT

Background: Pericardial effusion (PE) develops very frequently after cardiac surgeries. It is one of the critical causes of cardiac tamponade developing after coronary artery bypass grafting (CABG). Posterior left pericardiotomy (PP) is a simple, easy, and efficient procedure in which the left pleural cavity is used to drain the pericardial area.

Objectives: we aimed at 2 targets for our study. First, to detect the protectivity power of posterior pericardiotomy (PP) technique after CABG against the occurrence of early and late pericardial effusion (PE). Second, to detect the effect of posterior pericardiotomy (PP) procedure for preventing tamponade as a complication.

Patients and Methods*:* A prospective randomized clinical trial was accomplished between November 2016 and November 2018 including 120 consecutive patients underwent CABG, in Elkasr Elaini Medical Center, Cardiovascular Surgery Department, Cairo University. Patients were allocated in two groups: 60 patients for each. Group 1 was a control one and Group 2 was a posterior pericardiotomy intervention group where a T-shaped incision was created from left inferior pulmonary vein to the diaphragm.

Results: detected early PE in 13 patients (22%) in control group versus only in 3 patients (5 %) in PP group ($p < 0.001$). There was no late PE effusion or posterior tamponade noticed in the intervention group despite 6 (10 %) late PE developing ($p < 0.001$) and 7 (12%) posterior tamponade occurring in control group ($p < 0.002$).

Conclusion: It could be concluded that posterior pericardiotomy (PP) has a beneficial effect in lowering the incidence of early and late pericardial effusions (PE) and cardiac tamponade in patients undergoing CABG surgery.

Keywords: Posterior Pericardiotomy, Pericardial Effusion, CABG surgery, Tamponade.

INTRODUCTION

Pericardial effusion (PE) occurred in a high rate, about 65 % of patients, after cardiac operations [(1)]. It is also one of the causes of Atrial fibrillation (AF) developed following coronary artery bypass grafting [(2)].

According to study definitions and designs, PE rates varies from 1% to 85% [(3)]. It is generally insignificant and in modest amounts. However, PE may be self-limiting and does not need any treatment (it may be discovered through computed tomography or control echocardiography), or it may be regional and loculated, or it may prolong recovery in large effusion, or it may be life-threatening and impedes cardiac filling, reduces cardiac output, and leads to tamponade [(4,5)].

First, the regional PE are posterior located and associate with high mortality rates if the treatment delays [(6–8)]. Second, the large PE occur between day 4 to day10 after surgery in 30% of patients with bleeding in early postoperative days , after valve surgeries, and in cardiac transplant receivers [(4,6)].

Third, in 1% of patients, cardiac tamponade occurs after days or weeks from surgery, especially in anticoagulants treated patients [(4)].

Finally, Delayed PE, may be moderate or massive, represent 1.11 % of cases leading to posterior cardiac tamponade in 40 % of these patients [(9)]. Late cardiac tamponade is infrequent, develops in about 6 % of patients after cardiac surgery, but has serious adverse prognosis [(10)].

Atrial fibrillation (AF) has high incidence as a postoperative complication [(11)]. According to the operation type and evaluation methods, AF occurs in 30 to 40% of patients [(12)]. It has a great link to long hospital stay and high adverse events, as stroke and high mortality rates [(1)].

The key cause mechanisms of AF after CABG are autonomic dysfunction, inflammation, structure and electric remodeling and oxidative stress [(13)]. In addition, there is evidence related to the reduction of AF by the off-pump CABG rather than the on-pump procedure [(14)].

Posterior left pericardiotomy (pp) is an easy, simple and efficient technique in which the left pleural cavity is used to drain the pericardial area [(15)]. During heart surgery, the retrosternal area may collect liquid and is simply drained from a chest drain; but, fibrous strands between the cardiac inferior surface and the diaphragm may develop an enclosed room [(8)].

Mulay and colleagues [(15)] stated that PP might easily drain blood into the left pleural area. In their study pericardial effusion was lower (8%) in intervention group (PP) than control one (40%). Furthermore, it significantly reduces late PE and late posterior tamponade [(9)].

For full PE draining, two drains are essential in chest, one in the anterior mediastinum and one in the left pleural cavity [(16)].

Several trials ascertain that PP is also a costly beneficial and efficient procedure for controlling post-cardiac operations complications as AF [(17–19)].

In a systematic review and meta-analysis study, **Gaudino *et al.*** [(20)] stated that there was high and significant link between posterior left pericardiotomy and the AF incidence reduction after CABG, aortic surgery, or aortic valve. In addition, there was no postoperative adverse events or complications when compared to control group.

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In contrary, opposite findings in other studies found that PP may not lower the AF occurrence after coronary bypass [21–23]. As a result, the technique isn't regularly operated through heart surgeries because of the uncertain evidence.

As large pericardial effusion and tamponade is an important issue in post cardiac surgery management and as posterior pericardiotomy is one of its recent solutions, we conducted this trail to test both the efficiency and safety of left posterior pericardiotomy for protection against the early postoperative pericardial effusion and also late pericardial effusions after coronary bypass grafting.

MATERIAL AND METHODS

This prospective randomized clinical study included a total of 120 consecutive patients underwent CABG, attending at Department of Cardiovascular Surgery, Elkasr Elaini Medical Center, Cairo University. This study was conducted between November 2018 and November 2019.

Ethical consent:

This study was ethically approved by Cairo University Academic and Ethical Committee. Written authorized informed consent of all the participants was obtained. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Inclusion and exclusion criteria

Based on selective coronary angiography, patients who fitted to the study were identified with multi-vessel coronary artery disease (CAD) and underwent CABG surgery. Patients with valvular or congenital heart disease were not included in this study.

Study treatments and data collection

All patients allocated randomly depending on the Random Digits table [24]. Patients were equally allocated into two groups: one and two, with 60 patients for each. Group 1 was a control one and Group 2 was a left posterior pericardiotomy intervention group where a T-shaped incision was created from left inferior pulmonary vein to the diaphragm taking care not to injure phrenic nerve as stated by **Mulay and coworkers** [15]. In both groups, two chest tubes were placed. One chest tube was inserted in the left pleural cavity and one in anterior mediastinum.

Surgical technique

Both groups used identical medications for anesthesia and operation type. All patients underwent traditional median sternotomy. About 300 U/kg as Heparin loading dose was administrated for patients before cardiopulmonary bypass (CPB) for accomplishing an activated clotting time (ACT) higher than 450s using Hemochron 80, International Technidyne Corp., Edison, NJ as a coagulation machine. Then, extra heparin dose was administrated to keep the ACT higher than 45s. Additionally, Dideco, D708 Simplex III, Mirandola, Italy was used as a membrane oxygenator in CPB.

A dose of 2500 U of heparin, mannitol and ringer solution were used for priming extracorporeal circuit. Before dissuading from the CPB, all patients were returned to their normal temperature (37°C) and left to drift. In addition, they underwent warm blood cardioplegia for myocardial protection and received antegradely. Before declamping the aorta, they also received a hotshot cardioplegia.

Drains were milked at 30-minute frequencies after chest closure to verify tube efficient drainage. Once the amount draining was lower than 20 mL/h for sequential 4 hours, the chest tubes were withdrawn the next day. As a coagulation protection, aspirin administrated for all patients at the day 1 from surgery.

As ascertained by **Martin and colleagues [25],** the examination of effusions and cardiac tamponade location and amount was conducted using echocardiography with Doppler inspection, as others [15, 16]. At the tip of the mitral location, the greatest diastolic spacing between pericardium and epicardium was recorded. Regarding the effusion measurement, if the effusion was longer than 1 cm, it considered to be significant. All effusions or cardiac tamponade findings were documented for patients during 1st day postoperative and was reassessed in days 3 post surgery, then before discharge

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as frequencies and relative percentages. Chi square test ($\chi 2$) to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (Standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value < 0.05 was considered significant.

RESULTS

Patients were allocated in two groups: 60 patients for each. Group 2 was a left posterior pericardiotomy intervention group and group 1 was a control group (Figure 1).

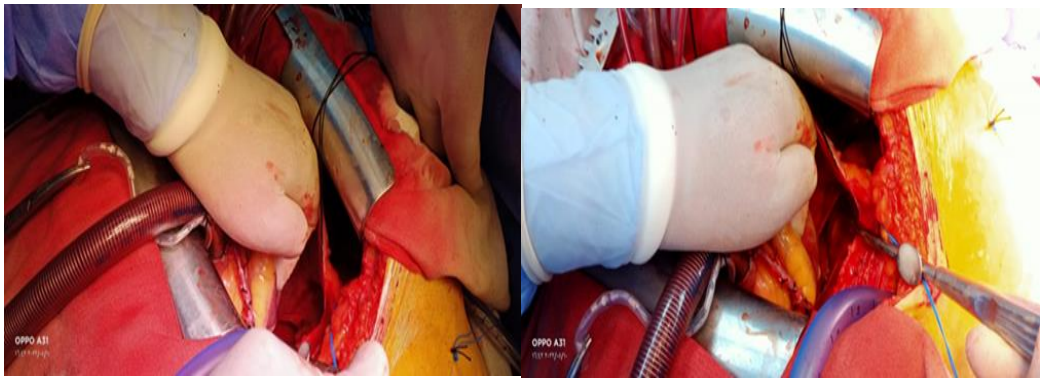

Figure (1): Posterior Pericardiotomy Inverted T-shaped Fashion.

There was no statistically difference among two groups' patients as regards demographic and clinical characteristics: age, sex, medications, underlying diseases, operation type and preoperative EF, coagulation abnormality as demonstrated in **the following tables.**

Table (1): Demographic Characteristics and Preoperative Data of Study Patients

Preoperative data	Group 1 (n = 60)	Group 2 (n = 60)	p Value
Sex (F/M)	6/54	2/58	ns
Mean age (years)	52.6 ± 5.9	56.3 ± 6.8	ns
Diabetic (YES/NO)	34/26	34/26	ns
HTN (YES/NO)	40/20	29/31	ns
COPD (YES/NO)	4/56	0/60	ns
Hyperlipidemia (YES/NO)	5/55	5/55	ns
AF (YES/NO)	5/55	0/60	ns
Previous MI	13/47	13/47	ns
Preoperative ejection fraction	58.7 ± 10.7	58.4 ± 9.3	ns
Left main disease	1/59	4/56	ns

Table (2): Comparison of Operation Data for Both Groups

Operation data	Group 1 (n = 60)	Group 2 (n = 60)	p Value
Cross-clamp time (min)	80 ± 18.9	75.97+_9.58	P < 0.16
Total bypass time (min)	127.4 ± 35.3	106.2 ± 11.7	p < 0.001
Inotropic support(YES/NO)	48/12	9/51	ns

F = female; M = male; CPB = cardiopulmonary bypass; ns = not significant.

By comparing postoperative data among both groups, early PE was significantly different , it was 13 (22%) in control group vs 3 (5%) patients in intervention group ($p < 0.001$). Late effusion and posterior tamponade was developed only in control group (6 (10%) and 7 (12%) patients; $p < 0.001$ and < 0.002, respectively). Also, there was statistical difference between both groups regarding the hospital stay, it was higher in group 1 than PP intervention group ($p < 0.001$) **(Table 3).** There was statistical difference between both groups regarding, total bypass time, ICU stay ventilation time and total drainage. They were higher in group 1 without intervention than PP group, p values were < 0.001, < 0.01, < 0.021, < 0.004 respectively, as illustrated in (**Table 3**).

The need for exploration for bleeding and the inotropic support need were not significantly different in both groups ($p > 0.05$). The pleural effusion and pulmonary complications were very low and nearly the same in both groups. There was no mortality among patients in two groups.

Table (3): Comparison of Postoperative Data for Both Groups

	Group 1 (n = 60)	Group 2 (n = 60)	p Value
Exploration for bleeding	9 (15%)	3 (5%)	ns
Need of positive inotropic support	11 (18%)	8 (23%)	ns
Pleural effusion	4 (7%)	4 (7%)	ns
Pulmonary complication	2 (3%)	1 (2%)	ns
Early pericardial effusion	13 (22%)	3 (5%)	p < 0.001
Late pericardial effusion	6 (10%)	0 (0%)	p < 0.001
Posterior tamponade	7 (12%)	0 (0%)	p < 0.002
Abnormal coagulation profile (n)	4 (7%)	2 (3%)	ns
Phrenic nerve palsy	0\60	0\60	ns
ICU stay days	4.4_+2.6	2.1_+0.43	p < 0.01
Total drainage	881+_460	730+_274	P < 0.004
Subxyphoid drainage	3/57	0/60	ns
ventilation	8.81±11.7	5.11±2.13	P < 0.021
Hospital stay (Days)	14.77±6.624	8.3±1.69	p < 0.001

ns = not significant

Subxiphoid exploration was used for management of symptomatic delayed posterior pericardial tamponade in 5 patients of group 1, and median sternotomy was used in 2 patients only in same group.

DISCUSSION

Postoperative pericardial effusion is a frequently met adverse event following heart surgeries. It occurs frequently up to 85% in patients undergo CABG with high morbidity and mortality rates. The majority of PE patients are self-limited, only few cases may complain poor prognosis when cardiac tamponade develops (with 1% to 31% incidence based on the cardiac operation type) [(26)]. Whereas early pericardial effusion or tamponade happen during day one of surgery, late pericardial effusion or tamponade occur in day 5 to 7 from surgery and they are diagnosed with difficulty [(27)].

The goal of our study was to demonstrate the effect of PP in lowering the PE occurrence and related adverse events after CABG surgery. In patients undergoing CABG a chest drain can quickly drain the pericardial fluid that has accumulated in the space adjacent to the heart. However, because pericardial adhesions are commonly seen between the inferior-posterior heart's outer surface and the diaphragm, they might form an encapsulated space and make draining blood complicated.

In addition, a tiny quantity of posteriorly located pericardial effusion may also impair both left atrial and ventricular area, leading to localized tamponade, so, the expanding area of left pleural cavity next to the pericardial area is advantageous but not an absolute a cure for all tamponade cases.

Adding a posterior pericardial window helps the collected accumulation to be readily drained to the left pleural space through the pericardotomy.

In our study, there was no difference among two groups' patients regarding demographic and clinical characteristics (age, sex), medications, underlying diseases, operation type and preoperative EF or coagulation abnormality.

According to this study, there was a significant difference regarding early and late PE and posterior cardiac tamponade among both groups, whereas these events were higher in control group than PP intervention group

Nearly, it was the same findings of **Balbaa *et al.*** [(16)] trial which detected 11.1 % PE in PP group and 42.2% in control group.

Likely, the results were similar to prospective randomized case-controlled study in Egypt, indicating that a posterior pericardiotomy after coronary artery bypass graft had high reduction effect in postoperative pericardial effusion development and severity. Also, it protected against delayed tamponade events. Thus, **Amr *et al.*** [(28)] detected that the incidence of these events, including early and late PE , developed about 54% and 21% among patients without intervention respectively. Also, the incidence of delayed tamponade may totally disappear in intervention group (0%) vs. (10%) in control group.

Similarly, **Xiong *et al.*** [(29)] showed in their systematic review, the efficiency of PP in protection against PE, cardiac tamponade, and new-onset AF among adults underwent coronary bypass grafting with few associated consequences.

Furthermore, in systematic review of **Gozdek *et al.*** [(30)], it ascertained PP safety and efficacy on posterior pericardial drainage. **Gozdek *et al.*** [(30)] tested PP procedure with chest tube versus inserting a flexible chest tube posterior to the heart only. This study recommended that surgeons should usually place both a soft flexible rubber posterior pericardial tube and an anterior mediastinal tube for the protection against adverse consequences.

The requirement to expose the left pleural space and a chest tube insertion is a disadvantage of this preventative surgical approach. Because of the potential of nerve damage, many surgeons are hesitant to do PP.

In this study, we didn't find any adverse events after placement of chest tube in left pleural cavity. We used T inverted sharp incision on posterior pericardium. We prefer low-powered electro cautery in making the pericardiotomy rather than sharp partition. We didn't find any injuries related to phrenic nerve related to raising of left hemi diaphragm. Similarly, **Balbaa *et al.*** [(16)] used T inverted sharp incision on posterior pericardium in their trial to avoid complications, and similarly several studies showed no phrenic nerve damage [(15,18,20)].

While we detected significant difference regarding total bypass time, total drainage, ICU and hospital stays and ventilation time. They were higher in group 1 without intervention than PP intervention group. Furthermore, our results indicated that there were no adverse events as lung complications. Also, there was no effect of PP procedure on revision surgery for bleeding or inotropic support usage.

In contrary, many other studies showed that PP intervention did not affect ventilation time, ICU stay, and hospital stay [(15–17,23,28)]. There was no significant difference in ventilation time, ICU stay, and hospital stay between the two treatment groups. In a study in Thailand, ICU stay showed significant difference rather than hospital stay [(22)].As our study, many studies didn't find significant difference regarding mortality or the occurrence of pleural pulmonary consequences among comparable groups. Finally, we didn't find any adverse consequences related to using posterior pericardiotomy technique, so, our study ascertained it's efficacy and safety for protection against both early and late pericardial effusions and delayed posterior cardiac tamponade development among patients underwent coronary bypass grafting.

CONCLUSION

The addition of our findings to the previous evidence related to the great intervention effect, PP

ought to be used through most cardiac operations. PP is a helpful procedure for lowering both early and late pericardial effusions and delayed posterior cardiac tamponade incidences following heart surgeries without any adverse consequences and has outperformed traditional surgical practices.

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Author contribution: Authors contributed equally in the study.

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