The Posterior Pericardiotomy. Does it Reduce the Incidence of Postoperative Atrial Fibrillation after Coronary Artery Bypass Grafting?

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Atrial fibrillation (AF) is the most common arrhythmia after coronary artery bypass graft surgery (CABG). Posterior pericardiotomy (PP) has been reported toreduce pericardial effusion, AF trigger, and reduce the length of hospital stay and hospital costs without significant complications. A total of 20 patients, diagnosed with coronary artery diseases to be treated by an elective or urgent CABG between August and December 2013, were randomly divided into two groups; 10 patients received PP (PP group) and 10 patients did not receive PP (control group). The incidence of AF was equal (40% in both groups). Early pericardial effusion was slightly higher in the PP group (PP 70%, control 60%; p = 1.00). The incidence of left pleural effusion and pneumonia were higher in the PP group than in the control. Moreover, one patient in the PP group developed perioperative myocardial infarction (MI) that required intensive care with medication. The duration of ICU stay of the PP group was significantly longer than that of the control group. In conclusion, PP did not reduce the incidence of postoperative AF nor did early pericardial effusion.Rather, PP increased post-operative complications such as perioperative MI, left pleural effusion, and pneumonia resulting in the prolonged ICU stay.

Keywords: *Atrial fibrillation, Posterior pericardiotomy, Pericardial effusion, Coronary artery bypass surgery*

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Atrial fibrillation (AF) is the most common arrhythmia after coronary artery bypass graft (CABG), with the incidence of 20-40%[1-3]. Although AF is generally a benign event,it may cause serious complications such as hypotension, heart failure and renal failure if not treated properly. AF causes emboli which may travel along the arterial system to cause an obstruction, especially embolic stroke. These complications cause increased cost and a prolonged hospital stay. Post-operative AF is a multi-factorial event including systemic and atrial inflammation, sympathetic stimulation, electrolyte imbalance, pericarditis and pericardial effusion.

Many efforts have been made for the effective prevention of post-operative AF. For example, various pharmacologic agents such as preoperative β-blocker, sotalol, amiodarone, magnesium, calcium channel blocker and anti-inflammatory drugs such as steroids, statins and omega fatty acid[3] have been used. Also, intraoperative intervention such as mild hypothermia, heparin-coated cardiopulmonary bypass (CPB) circuits and the posterior pericardiotomy (PP)[2] have been explored.

The posterior pericardiotomy(PP) was first applied by Mulay et al 1995[4] to reduce the pericardial effusion that often collected preferentially in the posterior and lateral pericardial space[5]. Pericardial effusion is considered an important AF trigger. Previous studies[4,6,7] reported that PP could reduce the incidence of AF thereby reducing the length of hospital stay and hospital costs without significant complications. From their evidence, we considered that PP should be a safe and beneficial maneuver. However, some randomized controlled studies showed contradictory results[8,9], in that PP could reduce post-operative pericardial effusion significantly but not reduce the incidence of post-operative AF.

The practical advantage of PP is the easiness

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to perform without any additional cost. In this study, we analyzed our own cases whether PP could actually reduce the incidence of postoperative AF and/or early pericardial effusion after isolated CABG.

Material and Method

Patients selection and randomization

The subjects of this study were patients diagnosed as having a coronary artery disease that required an elective or urgent isolated coronary artery bypass graft surgery (CABG) in the Srinagarind Hospital and the Queen Sirikit Heart Center of the Northeast, Khon Kaen University, Thailand. The sample size of this study was determined according to the previous study[6], with the power of 80% and 95% confident interval, and determined p = 0.11 and q = 0.28 (the incidence of postoperative AF from prior studies; p = PP, q = control), giving the number of 170 patients. The inclusion criteria were the age between 18-75 years old, the American Society of Anesthesiologists (ASA) classification I-III, ejection fraction (EF) >35%, and informed written consent was obtained individually. Exclusion criteria were patients who had previous history of AF or another cardiac arrhythmia, end stage renal disease (ESRD; glomerular filtration rate (GFR) <15 ml/min), coagulopathy, thyrotoxicosis, history of chronic obstructive pulmonary disease, chronic bronchitis, pulmonary tuberculosis, valvular heart disease, immunocompromised and a history of prior cardiac operation.

Between August 2013 and December 2013, there were 30 eligible patients, 10 of them were excluded due to not fulfilling the inclusion criteria (n = 3), declined to participate (n = 2) and other reasons (n = 5) that are immunocompromised (1), ESRD (2), valvular heart disease (1) and a history of prior AF (1). The remaining 20 patients were divided randomly by a block of four randomizations to two groups; that are the posterior pericardiotomy (PP) group (10 patients) and the control group (10 patients). The group codeswere kept in the secured envelopes and attached with the patient's chart to be opened in the operating room by the circulating nurse, at the time before removing partial aortic cross clamp. Blinding was also a consideration for the patient, the nurse who took care of the postoperative period and the researcher who analyzed the data.

The present study is a prospective, randomized and controlled trial. Ethical permission was approved by the Khon Kaen University Ethics Committee for Human Research based on the Declaration of Helsinki and ICH good clinical practice guidelines in order of 4.2.02: 10/2013 Reference No. HE561042.

Surgical technique

The patients were operated on by six experienced surgeons in our institute, all of whom have an experience of more than 50 cases of open heart surgery. All of the patients received the same general anesthesia and median sternotomy. The left mediastinal pleura was opened anteriorly, then the left internal mammary artery(LIMA) was harvested in all patients. In addition, the greater saphenous vein and/or radial artery were harvested according to the clinical conditions and indications of each patient. Standard cardiopulmonary bypass with a roller pump was established, and heparin was given to maintain activated clotting time (ACT) >480 sec. Systemic mild hypothermia (body temperature 32-34°C) was achieved. The aortic cross clamp was applied, and the antegrade or combined retrograde cardioplegia technique was used as needed. When distal anastomosis was done, the patient was rewarmed, and then the aorta was partially clamped for proximal anastomosis. Then, for the PP group, a 4-cm circular incision was made in parallel and posterior to the left phrenic nerve, extending from the left inferior pulmonary vein to the diaphragm as described by Mulay et al 1995[4] (Fig. 1),

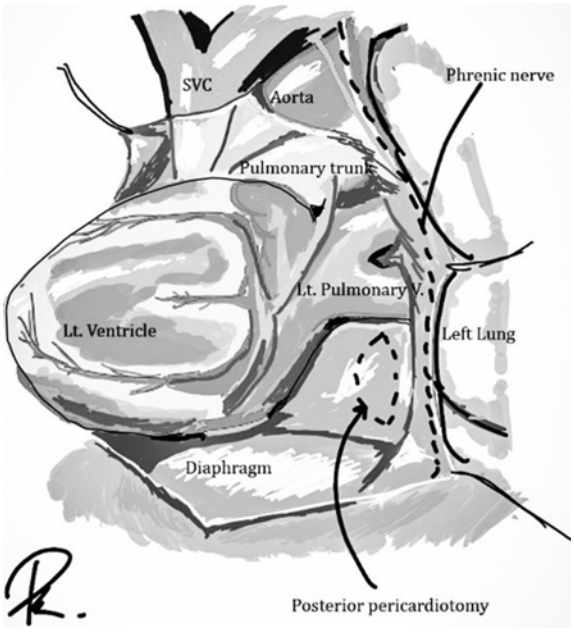

Fig. 1 Posterior pericardiotomy as described by Mulay et al 1995[17].

before removal of the partial clamp. Heparin was reversed by protamine. One drainage tube was inserted into the left thorax and one or two into the anterior mediastinum, without suction, and the drainage tubes were removed postoperatively when the content was less than 100 ml per day.

Postoperative monitoring

The patients were monitored by electrocardiography (EKG) continuously for the postoperative period at least 72 hours to detect arrhythmia and any other problems. An additional EKG was obtained at 6:00 AM daily and also depending on the patient symptoms. Any atrial fibrillation (AF) that occurred was considered as a serious problem, and the antiarrhythmic drug (amiodarone) treatment was appliedtogether with the investigation for other problems such as electrolyte imbalance, fever, sepsis, dehydration, pain, etc.

Serum electrolytes such as potassium (K), calcium (Ca) and magnesium (Mg) were monitored every 6 hr for initial 72 hr, and then once a day at 6:00 AM. Additional monitoring was made whenever arrhythmia occurred and their level was maintained at 4-5 meq/Lfor K, 8-10.5 meq/L for Ca and 1.8-2.4 meq/L for Mg using supplements.

The presence of pericardial effusion was assessed by 2D echocardiography during the first week of post-operation and before the discharge to detect the risk of tamponade. Any effusion image of >1 cm between the epicardial and pericardial surface was considered as significant.

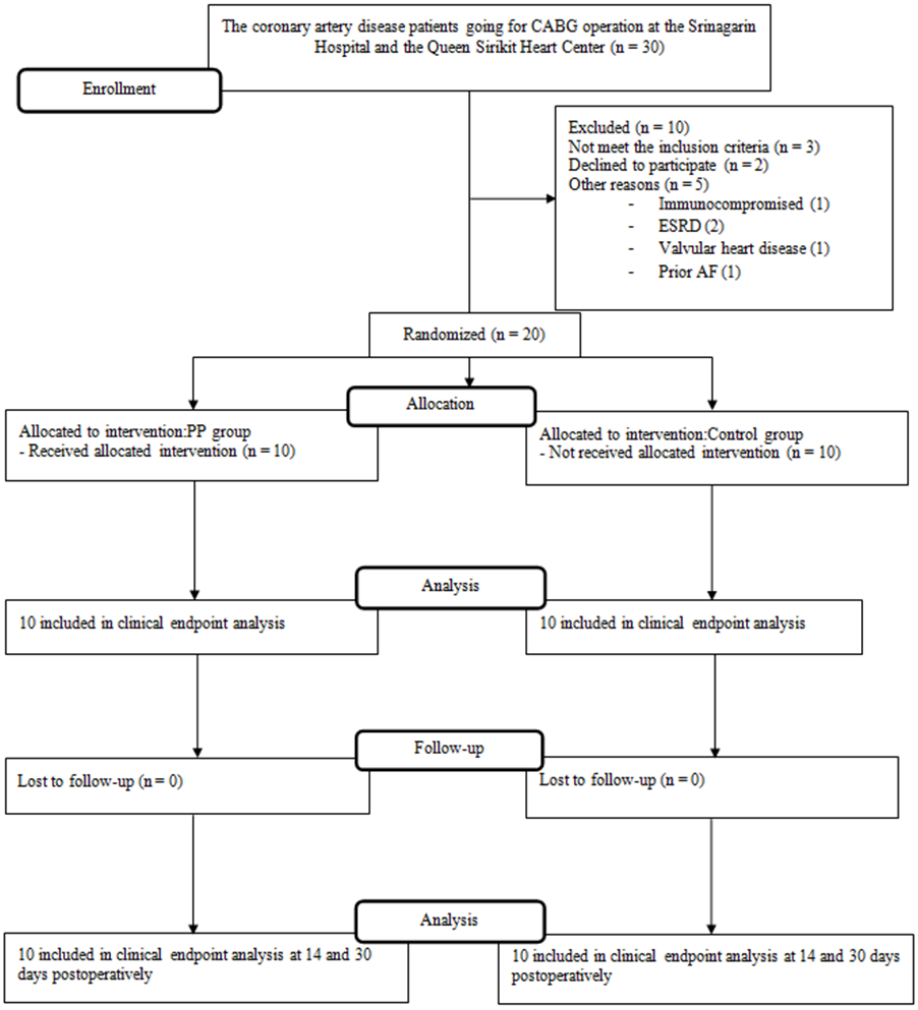

Fig. 2 The study protocol.

Follow-up protocol

After the patients were discharged, they were appointed for 2 weeks post-operative assessment which included the general condition, EKG to detect the occurrence of AF, plain chest radiogram to detect pleural effusion and pericardial effusion. Then they were invited for 30 days post-operative assessment to monitor the general condition and the occurrence of AF. Echocardiography was performed if the pericardial effusion was suspected clinically or chest x-ray examination, or if AF was present.

Statistical analysis

The authors used SPSS version 17.0 for statistical analysis. Clinical data are expressed as mean ± SD. Differences were analyzed with Chi-square, Fisher's exact test and independent t-test as indicated. The *p*-value <0.05 wasconsidered as statistically significant.

Results

When the preoperative data between the PP and control groupswere compared (Table 1), there's no difference in the parameters examined except for the mean age, which was significantly higher ($p = 0.02$) in the PP (64.9±13.11 years) than in the control group (59.2±4.69 years).

All the intraoperative clinical data (Table 2) were also not significantly different between the PP and control groups. The antegrade cardioplegia was used to stop the heart for all the cases. Retrograde cardioplegia wasnot performed. The LIMA was used in all cases and the radial artery was used for one case of the PP group and two cases of the control group. And the SVG were used in the remaining patients. Although statistically not significant, the prevalence of arrhythmia and the necessity for the intraoperative defibrillation were slightly higher in the control group than in the PP group.

The incidence of post-operative AF was equal in PP (40%) and the control (40%) (Table 3). In all those cases, AF developed within the 2nd post-operative day, mostly in the 2nd day. The duration of AF in the control group was, although statistically not-significant, slightly longer than that of the PP group (Table 3). There were no recurrent AF after treatment with anti-

Table 1. Preoperative data of PP and control groups

Parameters	PP group (%) n = 10	Control group (%) n = 10	*p*-value	95% CI
Mean age (years) X ± SD	64.9±13.11	59.2±4.69	0.02	1.01-10.39
Sex (M/F)	5/5	5/5	1.00	
Preoperative MI			0.77	
STEMI	2 (20%)	3 (30%)		
NSTEMI	6 (60%)	6 (60%)		
Ejection fraction			0.16	
Good >50	8 (80%)	5 (50%)		
Moderate 35-50	2 (20%)	5 (50%)		
DM	6 (60%)	5 (50%)	1.00	
HT	8 (80%)	9 (90%)	1.00	
CKD			0.22	
Moderate (GFR 50-85)	0 (0%)	2 (20%)		
Severe (GFR <50)	1 (10%)	0 (0%)		
Hypercholesterolemia	5 (50%)	4 (40%)	1.00	
Preoperative statin	10 (100%)	9 (90%)	0.30	
Smoking habit	0 (0%)	3 (30%)	0.21	
Preoperative β-blocker	9 (90%)	7 (70%)	1.00	
Pre-op inotropic drug	1 (10%)	0 (0%)	1.00	
Operation			1.00	
Elective	8 (80%)	9 (90%)		
Urgent	2 (20%)	1 (10%)		
Euroscore II	1.09±0.61	0.98±0.23	0.59	-0.34-0.56

MI = myocardial infarction; DM = diabetes mellitus; HT = hypertension; CKD = chronic kidney disease

Table 2. Comparison of the intra-operative data between PP and control groups

Parameters	PP group n = 10	Control group n = 10	*p*-value	95% CI
Aortic cross clamp time	84.4±37.7	106.8±39.4	0.21	-58.67-13.87
CPB time	127.5±48.9	152.3±45.1	0.25	-69.04-19.44
Distal bypass count	4.00	4.20	0.43	-0.72-0.32
LIMA usage	10 (100%)	10 (100%)	-	
Radial artery usage	1 (10%)	2 (20%)	1.00	
Coronary endarterectomy	1 (10%)	3 (30%)	0.58	
Arrythmia during weaning off CPB	1 (10%)	4 (40%)	0.30	
Intraoperative defibrillation	1 (10%)	4 (40%)	0.30	

CPB = cardiopulmonary bypass; LIMA = left internal mammary artery

Table 3. Post-operative clinical data of PP and control groups

Parameters	PP group n = 10	Control group n = 10	*p*-value	95% CI
Atrial fibrillation	4 (40%)	4 (40%)	1.00	
Post-op day that AF occurred			0.549	
Day 0	1 (10%)	0 (10%)		
Day 1	1 (10%)	1 (10%)		
Day 2	2 (20%)	3 (30%)		
AF Duration (days)	2.75±1.70	5.00±4.24	0.38	-8.63-4.13
Drain (ml)				
Left pleura	612.0±411.9	331.7±225.7	0.075	-31.73-592.33
Mediastinum	464.0±382.5	201.0±116.8	0.063	-16.46-542.46
Drainage duration (days)	3.8±1.9	2.6±1.0	0.094	-0.24-2.64
Cardiac tamponade	0 (0%)	0 (0%)	-	
PRC transfusion	720.60±435.12	393.80±182.14	0.049	1.98-651.62
Reoperation	1 (10%)	0 (0%)	1.00	
Perioperative MI	1 (10%)	0 (0%)	1.00	
IABP insertion	0 (0%)	0 (0%)	-	
Pneumonia	3 (30%)	0 (0%)	0.211	
Pleural effusion	10 (100%)	5 (50%)	0.028	
No need for ICD	9 (90%)	5 (50%)		
Need for ICD	1 (10%)	0 (0%)		
ETT duration			0.14	
≤24 Hrs	5 (50%)	9 (90%)		
>24 Hrs	5 (50%)	1 (90%)		
Re-ETT intubation	1 (10%)	0 (0%)	1.00	
ICU stay (days)	4±2	2.2±1.62	0.04	0.09-3.51
Re-ICU admission	1 (10%)	0 (0%)	1.00	
Hospital stay (days)	16.40±6.08	13.60±8.29	0.40	-4.03-9.63
Early pericardial effusion by Echo	7 (70%)	6 (60%)	1.00	

ETT = endothracheal tube intubation; IABP = intraaortic balloon pump; ICU = intensive care unit; Echo = echocardiogram; ICD = intercostal chest drainage; MI = myocardial infarction

arrhythmic (Amiodarone), and none of the patients needed electrical cardioversion.

The amount of drain contents from the left pleura and the mediastinumtended to be higher in PP

group, although statitically not significant. The duration to remove the drains was also longer in PP group but statistically not significant (Table 3). PP group needed more of the postoperative packed red blood cell (PRC) transfusion than control. The prevalence of pleural effusion that occurred after removal of the drains was significantly higher in PP group than in the control (Table 3) and one of the patients in PP group suffering from pleural effusion needed to be retained the left ICD.

The incidence of pneumonia in the PP group was higher than that in the control, although statistically not significant (Table 3). Consequently, one of the pneumonia patients in the PP group needed to be re-intubated due to a respiratory failure and was re-admitted to the ICU. One of the patients in the PP group was re-operated immediately after CABG because of the bleeding from the side branch of SVG. Early pericardial effusion was observed almost equally in both groups (Table 3), butnone of them needed any intervention. On the follow-up 2 weeks and 30 days after discharge, all the cases showed normal sinus rhythm inthe EKG, and pleural or pericardial effusion was not observed in chest x-ray examination.

The mean duration of intensive care unit (ICU) stay of the PP group was significantlylonger than that of the control (Table 3), mainly due to pleural effusion, pneumonia and perioperative MI. None of the patientsin either group needed an IABP support, and there were no incidence of stroke or death.

One patient in the PP group, a 61 years old woman diagnosed as triple vessels with left main disease received CABG x 4 vessels anastomoses with LIMA to left anterior descending artery (LAD), SVG to obtuse marginal1 artery (OM1), SVG to diagonal 1 artery (DG1) and SVG to posterior descending artery (PDA). Inthis case, the aortic cross clamp and CPB time was 70 min and 107 min, respectively. On the first post-operative day, she complained anterior chest pain. Her laboratory data showed significant elevation of cardiac enzymes (CK-MB 152 U/L, troponin-T 8394 ng/L) and V2-V5 ST-segment elevation in the EKG, and she was diagnosed as anterolateral wall perioperative MI. She was immediately treated with enoxaparin. Coronary angiogram revealed total occlusion of SVG to OM1. Because the patient's clinical chest pain and vital signs were improved after the medical treatment, and her cardiac enzyme also decreased gradually, no additional intervention or treatment was performed. She was transferred from the ICU to the ordinary ward on the 6th post-operative day and was discharged on the 13th post-operative day.

Discussion

The pre-operative and intra-operative risk factors were comparable between the PP and control group, except that the mean age of the PP group was slightly, but significantly, higher than that of the control group.

In our study, the incidence of postoperative AF was 40% in both PP and control groups. In contrast, Kaygin et al[7] reported that the incidence of AF in PP group was 3.1% and that in the control was14.6% (p <0.0001). Similar findings were reported by Biancari and Mahar[6] in that the incidence of AF in PP group was 10.8% and that in the control was 28.1% (p = 0.003).

Regarding the difference between our data and others, they defined AF with the duration of >15 min or >20 min, while we defined AF regardless of the duration, because we considered any post-operative AF should be treated because it will increase the risk of complications. Therapeutic value of PP on reduction of AF remains controversial. Asimakopoulos et al[9] reported that AF occurred in the PP group slightly but not significantly higher than inthe control group. Arbatli et al[8] also reported that that the incidence of AF in the PP group was lower than in the control but statistically not significant (PP 13%, control 20%; p = 0.32).

Many previous studies[4,7,10-12] mentioned that PP would reduce post-operative AF by stimulation of pericardial drainage and decrease pericardial effusion. In our study, however,the incidence of early pericardial effusion in the PP group was almost comparable to that in the control group, and no additional problem occurred with these effusions and intervention was not required in both groups.

In the present study, the incidence of left pleural effusion after removal of the drains was significantly higher in the PP group than in the control group and one of such patients in PP group needed left ICD insertion. Similarly, Erdil et al[13] as well as Ekim et al[10] reported slightly but statistically not significantly higher incidence of pleural effusion in PP than in control. Kaygin et al[7] reported that pleural effusion requiring intervention (>1,000 ml) was more frequent in the PP group than in the control. The patients with pleural effusion in our study also had other problems that are pneumonia (PP 30%, control 0%; p = 0.21) and one of them consequently received re-ETT intubation and then re-admitted to the ICU.

In the present study, the length of ICU stay in the PP group (4$\pm$2 days) was longer than that of the

control group (2.2±1.62 days) due to pleural effusion, pneumonia and perioperative MI. In contrast, Kaygin et al[7] reported that the incidence of the prolonged ICU stay of >3 days was significantly lower in the PP group than in the control group (PP 5.8%, control 12%; p = 0.001).

In the present study, one patient in the PP group developed an early perioperative MI, which was caused by a total occlusion of SVG to OM1 anastomosis. This serious complication is assumed to be resulted from thrombosis of the SVG itself or the herniation of SVG through the PP and was compressed by heart border and its edge, or the concomitant occurrence of both events. A similar but more serious case with the requirement of re-operation was reported by Yorgancioglu et al[14]. They reported that one patient developed lateral ST elevation and ventricular fibrillation (VF) immediately after CABG operation, and did not respond to defibrillation. The patient was re-operated because a segment of SVG was protruded and was squeezed by the edges of the PP incision. In our case, we did not re-operate the patient, because the patient had clinical improvement after the medication.

After the experience of this serious complication, the authors decided to terminate the study because this procedure might be harmful even if the authors couldn't exactly conclude that PP was a cause of graft obstruction. More fundamentally, the authors couldn't demonstrate obvious benefit of PP. Rather, the authors foundthat the prevalence of complications such as pneumonia, pleural effusion, requirement of more PRC transfusion and prolonged ICU stay in the PP group was higher than the control group operated with the conventional technique.

The limitations of our study are the too small sample size due to early termination and the possible variations of the surgical technique due to the involvement of six surgeons who operated.

Conclusion

In our situation, PP did not reduce the incidence of postoperative AF as well as early pericardial effusion. Rather, it increased post-operative complications such as perioperative MI, left pleural effusion, pneumonia and prolonged ICU stay.

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การเจาะช่องเยื่อหุ้มหัวใจทางด้านหลัง สามารถลดอุบัติการณ์ของภาวะหัวใจเต้นผิดจังหวะชนิดหัวใจห้องบนสั่นพลิ้วหลังการผ่าตัดเส้นเลือดหัวใจได้จริงหรือไม่

พีรพัฒน์ คงมาลัย, ชนัญญา กรุณาสุเมตตา, ชูศักดิ์ คุปตานนท์, สมภพ พระธานี, สุเทพ ทักษิณาเจนกิจ, วรวิทย์ อินทะนู, ชวลิต วงศ์พุทธะ, วิชัย เส้นทอง

ภาวะหัวใจเต้นผิดจังหวะชนิด Atrial fibrillation (AF) เป็นภาวะหัวใจเต้นผิดจังหวะที่พบได้บ่อยที่สุดหลังการผ่าตัดเส้นเลือดหัวใจ มีการศึกษาพบว่าการเจาะช่องเยื่อหุ้มหัวใจทางด้านหลัง (Posterior pericardiotomy: PP) สามารถลดการเกิดน้ำขังในเยื่อหุ้มหัวใจ ซึ่งเป็นสาเหตุสำคัญอย่างหนึ่งที่ทำให้เกิด AF รวมถึงลดระยะเวลาในการนอนโรงพยาบาลและลดค่าใช้จ่ายในการรักษาพยาบาลได้ โดยไม่ทำให้เกิดภาวะแทรกซ้อนอย่างมีนัยสำคัญทางสถิติ ระหว่างเดือนสิงหาคม ถึง เดือนธันวาคม พ.ศ. 2556 ผู้ป่วย 20 รายที่ได้เข้ารับการผ่าตัดเส้นเลือดหัวใจได้รับการสุ่มแบ่งเป็น 2 กลุ่มคือได้รับการทำ PP 10 ราย (กลุ่ม PP) และไม่ได้รับการทำ PP 10 ราย (กลุ่มควบคุม) พบว่าอุบัติการณ์เกิด AF ทั้งสองกลุ่มเท่ากัน (ร้อยละ 40) ภาวะน้ำขังในช่องเยื่อหุ้มหัวใจในกลุ่ม PP มากกว่าเล็กน้อย (กลุ่ม PP ร้อยละ 70, กลุ่มควบคุมร้อยละ 60; p = 1.00) พบอุบัติการณ์เกิดน้ำขังในเยื่อหุ้มปอดด้านซ้ายและการเกิดปอดอักเสบติดเชื้อในกลุ่ม PP มากกว่ากลุ่มควบคุมนอกจากนั้นผู้ป่วย 1 รายในกลุ่ม PP เกิดภาวะกล้ามเนื้อหัวใจขาดเลือดหลังผ่าตัดซึ่งต้องได้รับการรักษาตัวในหอผู้ป่วยวิกฤติและพบว่ากลุ่ม PP มีระยะเวลาการรักษาในหอผู้ป่วยวิกฤติ (ICU) มากกว่ากลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติโดยสรุป PP ไม่ได้ลดอุบัติการณ์เกิด AF รวมไปถึงภาวะน้ำขังในเยื่อหุ้มหัวใจหลังการผ่าตัดเส้นเลือดหัวใจ แต่ทำให้เกิดภาวะแทรกซ้อนมากยิ่งขึ้น เช่น ภาวะกล้ามเนื้อหัวใจขาดเลือด น้ำขังในเยื่อหุ้มปอดด้านซ้าย และปอดติดเชื้อ เป็นผลทำให้ผู้ป่วยต้องนอนใน ICU นานขึ้นอีกด้วย