

# Does posterior pericardiotomy reduce the incidence of atrial fibrillation after coronary artery bypass grafting surgery?

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## Abstract

A best evidence topic in cardiac surgery was written according to a structured protocol. The question addressed was whether posterior pericardiotomy (PP) reduces the incidence of atrial fibrillation (AF) after coronary artery bypass grafting surgery. Twelve papers were found using the reported search, of which seven represented the best evidence to answer the clinical question. The authors, journal, date and country of publication, patient group studied, study type, relevant outcomes and results of these papers were tabulated. One non-randomized prospective cohort controlled study generated early evidence that PP reduced the rate of postoperative AF and pericardial effusion. The operative details of PP were clearly explained in this paper. The efficacy of this procedure was subsequently examined in five prospective randomized controlled trials performed with some limitations, listed in the table. Meta-analysis of the randomized control trials examined a group of 763 patients (PP = 389, control = 374). It revealed a highly significant reduction in total arrhythmias and AF in the PP group (odds ratio 0.31 and 0.33, respectively). There was a 10.8% AF rate in the PP group (41/379) and a 28.1% AF rate in the control group (108/384). Furthermore, the PP group had a significant reduction in the rate of early and late pericardial effusion ( $P < 0.001$ ). Moreover, the reduction in the incidence of arrhythmias was significantly associated with the reduction in the incidence of pericardial effusion. Referring to these studies, two guidelines recommend PP to reduce postoperative AF with grade B strength of recommendation. We conclude that PP significantly reduces the incidence of postoperative AF. The number needed to treat to prevent one case of AF is six.

**Keywords:** Review • Posterior pericardiotomy • Atrial fibrillation

## INTRODUCTION

A best evidence topic was constructed according to a structured protocol. This is fully described in the *ICVTS* [1].

## CLINICAL SCENARIO

During a routine coronary artery bypass grafting operation (CABG), your consultant performs a posterior pericardiotomy (PP). On enquiry as to why she does this, she asserts that by doing so the chances of the patient developing atrial fibrillation (AF) postoperatively are reduced. Unfamiliar with the evidence base for this manoeuvre, you resolve to review the literature.

## THREE-PART QUESTION

In [patients undergoing coronary artery bypass grafting surgery] does [posterior pericardiotomy] reduce the incidence of [postoperative atrial fibrillation]?

## SEARCH STRATEGY

The search strategy used Medline 1948 to week 2 of June 2011 using the OvidSP interface (Posterior Pericardiotomy.mp).

## SEARCH OUTCOME

Twelve papers were found using the reported search. From these, seven papers were identified that provided the best evidence to answer the question. These are presented in Table 1.

## RESULTS

Mulay *et al.* [2] reported on their non-randomized cohort controlled study. The authors included 100 consecutive patients undergoing first-time isolated on-pump CABG in whom the left pleural cavity was opened. In half the number of patients a PP was performed. The authors explained this manoeuvre diagrammatically and clearly defined it as 'A longitudinal incision made parallel and posterior to the phrenic nerve, extending from the left inferior pulmonary vein to the diaphragm.'

Table 1: Best evidence papers

Author, date, journal, country Study type (level of evidence)	Patient group	Outcome measures	Key results	Comments
Mulay <i>et al.</i> , (1995), Eur J Cardiothorac Surg, UK [2]  Prospective cohort study (level 3)	100 consecutive patients undergoing isolated on-pump CABG in whom the left pleural cavity was opened were non-randomly divided into two groups to receive either posterior pericardiotomy (PP group, $n = 50$ ) or conventional procedure (control group, $n = 50$ )	Incidence of arrhythmias	PP/control 4 (8%)/18 (36%) ( $P < 0.005$ )	The study lacks information about redo procedures, serum potassium levels, thyroid hormones levels, renal function, COPD, medication that can potentially influence the incidence of AF (beta blockers, perioperative inotropes, statins) and risk factors of AF (hypertension, smoking, diabetes, hypercholesterolaemia)  There was no discussion of myocardial protection or CPB technique. In the control group, an extra drain was placed posterior to the heart. Echocardiography was carried out between the third and fifth postoperative days to detect pericardial effusion. The authors used Martin criteria for pericardial effusion [3]. Pericardial effusion was defined as significant if maximum diastolic separation between pericardium and epicardium was more than 0.5 cm  ECG was monitored continuously for the first 72 h after operation to detect arrhythmias. Subsequently, monitoring was re-instituted whenever symptoms of arrhythmia occurred. The patient was considered to have met the criteria for an episode of supraventricular arrhythmia when the AF or atrial flutter persisted despite correction of hypoxia or an electrolyte imbalance
	The groups were well matched for age, sex, number of grafts, CPB time, cross-clamp time and drug treatment (not defined)	Incidence of pericardial effusion	PP/control 4 (8%)/20 (40%) ( $P < 0.0005$ )	
	Antiarrhythmia medication was not given routinely to any patients postoperatively			
Asimakopoulos <i>et al.</i> (1997), J Thorac Cardiovasc Surg, UK [4] Non-blinded prospective randomized controlled trial (level 2)	100 patients undergoing isolated first-time on-pump CABG in a single centre were randomized to receive either PP ( $n = 50$ ) or no PP (control group, $n = 50$ )	Incidence of arrhythmias	PP/control 13 (26%)/10 (20%) ( $P > 0.05$ )	The study lacks information about thyroid hormones levels, renal function, COPD, postoperative medication that can potentially influence the incidence of AF (e.g. inotropes duration and institution of beta blockers)  ECG was monitored continuously for the first 48 h after operation to detect arrhythmias and subsequently by 12-lead ECGs if symptoms of arrhythmia occurred  No echocardiography was performed  Risk of arrhythmias and AF was lower in the control group but did not reach statistical significance  The main risk factor for postoperative AF in this study was advancing age
	The groups were well matched for age, number of grafts, LV function, preoperative beta blockers, diabetes, hypercholesterolaemia, smoking, hypertension, CPB time and cross-clamp time All operations were performed by a single surgeon with standardized myocardial protection and CPB	Incidence of AF	PP/control 12 (24%)/9 (18%) ( $P > 0.05$ )	
Kuralay <i>et al.</i> (1999), J Thorac Cardiovasc Surg, Turkey [5]	200 patients undergoing isolated on-pump CABG in a single centre were randomized to receive either PP ( $n = 100$ ) or no PP (control group, $n = 100$ )	Incidence of arrhythmias	PP/control 11 (11%)/40 (40%) ( $P = 0.000002$ )	The study lacks information about redo procedures, serum potassium levels, medication that can potentially influence the incidence

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Table 1: Continued

Author, date, journal, country Study type (level of evidence)	Patient group	Outcome measures	Key results	Comments
Non-blinded prospective randomized control trial (level 2)	Patients with hyperthyroidism, COPD, renal dysfunction, LV aneurysm, severe LV dysfunction, non-isolated CABG and those who received preoperative beta blockers were excluded from this study	Incidence of AF	PP/control 6 (6%)/34 (34%) ( <i>P</i> = 0.0000007)	of AF (perioperative inotropes, statins), risk factors of AF (hypertension, smoking, diabetes, hypercholesterolaemia)
		Incidence of early (before 30 days) pericardial effusion	PP/control 0 (0%)/21 (21%) ( <i>P</i> = 0.00001)	Echocardiography was performed on postoperative days 3, 5, 7 and 10 before discharge, and 1, 3, 6 and 12 months after discharge to detect pericardial effusion. The authors used Martin criteria for pericardial effusion [3]. Pericardial effusion was defined as significant if maximum diastolic separation between pericardium and epicardium was more than 1.0 cm
	Patients who had dense left pleural adhesions were excluded	Incidence of late (after 30 days) pericardial effusion	PP/control 1 (1%)/54 (54%) ( <i>P</i> = 0.00000001)	ECG was monitored continuously when patients were in the bed to detect arrhythmias, and if the patients were symptomatic, the authors used standard 12-lead ECGs
	A standard technique was used for CPB and myocardial protection			After discharging, the patients and their family were taught to monitor radial artery pulses at least thrice a day. Arrhythmias were recorded if they persisted for more than 30 min
	The groups were well matched for sex, number of grafts, LV function, CPB time and cross-clamp time			
Farsak <i>et al.</i> , (2002), Eur J Cardiothorac Surg, Turkey [6]	150 patients undergoing isolated on-pump CABG in a single centre were randomized to receive either PP ( <i>n</i> = 75) or no PP (control group, <i>n</i> = 75)	Incidence of arrhythmias	PP/control 10 (13%)/28 (37%) ( <i>P</i> < 0.01)	The study lacks information about redo procedures, serum potassium levels, preoperative medication that can potentially influence the incidence of AF (statins)
Non-blinded prospective randomized control trial (level 2)	Patients with hyperthyroidism, COPD, renal dysfunction, LV aneurysm, preoperative paroxysmic AF and those who received beta blockers were excluded from this study	Incidence of AF	PP/control 7 (9%)/24 (32%) ( <i>P</i> < 0.001)	Echocardiography was performed on postoperative days 1, 5, before discharge and 1 month after discharge to detect pericardial effusion. The authors used Martin criteria for pericardial effusion [3]. Pericardial effusion was defined as significant if maximum diastolic separation between pericardium and epicardium was more than 1.0 cm.
		Incidence of early (in-hospital) pericardial effusion	PP/control 8 (11%)/32 (43%) ( <i>P</i> < 0.0001)	ECG was monitored continuously for the first 96 h after operation, and, if needed, by using standard 12-lead ECGs to detect persistent clinically relevant AF. After discharging, the patients and their family were taught to monitor radial artery pulses at least thrice a day. Arrhythmias were thought to be persistent and clinically significant when they lasted more than 30 min
	The groups were well matched for age, sex, hypertension, smoking, diabetes, hypercholesterolaemia, number of grafts, LV function, CPB time and cross-clamp time	Incidence of late (1 month after discharge) pericardial effusion	PP/control 0(0%)/7 (9%) ( <i>P</i> < 0.013)	
	A standard technique was used for CPB and myocardial protection			
	The need for perioperative inotropes was non-significantly higher in the control group			
Arbatli <i>et al.</i> , (2003) J Cardiovasc Surg, Turkey [7]	113 patients undergoing isolated first-time on-pump CABG in a single center were randomized to receive either PP ( <i>n</i> = 54, age 62.3 ± 8.2 years) or no PP (control group, <i>n</i> = 59, age 60.1 ± 9.0 years)	Incidence of AF	PP/control 7 (13%)/12 (20%) ( <i>P</i> = 0.320)	The study lacks information about medication that can potentially influence the incidence of AF (perioperative inotropes, statins)
Non-blinded randomized controlled trial (level 2)	Patients with COPD, renal dysfunction, LV aneurysm, severe LV dysfunction, mitral regurgitation, history of AF, endocrine disorders, dense pericardial adhesions, dense left pleural adhesions and those who received beta blockers were excluded from this study	Mild to moderate pericardial effusion	PP/control 14 (26%)/28 (47%) ( <i>P</i> = 0.020)	The upper thymic fat was re-approximated whereas the lower pericardium was left open
				Echocardiography was carried out on the third and seventh postoperative days to detect pericardial effusion. The authors

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Table 1: Continued

Author, date, journal, country Study type (level of evidence)	Patient group	Outcome measures	Key results	Comments
	A standard technique was used for CPB and myocardial protection  The groups were well matched for age, sex, hypertension, smoking, diabetes, hypercholesterolaemia, number of grafts, LV function, CPB time, cross-clamp time and serum potassium levels			used Weyman criteria for pericardial effusion [8]. The amount of pericardial effusion was defined as minimal (0–50 ml), mild (50–100 ml), moderate (100–500 ml) and severe (>500 ml)  ECG was monitored continuously for the first 48 h after operation for detecting arrhythmias. Later ECG control was performed twice a day and routine heart rate and rhythm controls were done as well by the nurses in the ward periodically. AF sustained for more than 15 min was recorded as significant
Ekim et al., (2006), Med Sci Moni, Turkey [9]  Non-blinded randomized controlled trial (level 2)	100 patients undergoing isolated first-time on-pump CABG in two centres were randomized to receive either PP (n = 50) or no PP (control group, n = 50)  Patients with hyperthyroidism, COPD, renal dysfunction, LV aneurysm, severe LV dysfunction, valvular heart disease, previous CABG, dense lung adhesions and those who received beta blockers were excluded from this study  A standard technique was used for CPB and myocardial protection  The groups were well matched for age, sex, hypertension, smoking, diabetes, hypercholesterolaemia, number of grafts, LV function, perioperative inotropes, CPB time and cross-clamp time	Incidence of arrhythmias  Incidence of AF  Early (before 30 postoperative days) pericardial effusion  Incidence of late (after 30 postoperative days) pericardial effusion	PP/control 8 (16%)/19 (38%) (P = 0.011)  PP/control 5 (10%)/15 (30%) (P < 0.010)  PP/control 6 (12%)/21 (42%) (P < 0.0001)  PP/control 0(0%)/3 (6%) (NS)	The study lacks of information about medication that can potentially influence the incidence of AF (statins)  Echocardiography was performed on the third and fifth postoperative days, before discharge and after discharge to detect pericardial effusions, The authors used Martin criteria for pericardial effusion [3]  Pericardial effusion was defined as significant if maximum diastolic separation between pericardium and epicardium was more than 1.0 cm  ECG was monitored continuously for the first 96 h after operation for detecting arrhythmias. Additional ECGs were obtained daily  Arrhythmias were thought to be clinically significant when they lasted more than 20 min
Biancari and Mahar (2010), J Thorac Cardiovasc Surg, Finland [10]  Meta-analysis of multiple randomized controlled trials (level 1)	PubMed and Cochrane Library were searched between 1950 and February 2009  This systematic review included six studies [2, 4–7, 9] with a total 763 patients undergoing isolated first-time on-pump CABG  379 (49.7%) patients received PP and 384 (50.3%) received no PP (control group)	Incidence of arrhythmias  Incidence of AF  Incidence of early pericardial effusion	PP/control 13.8%/35.4% I <sup>2</sup> 70% (P = 0.002) OR 0.31, 95% CI 0.15–0.65 RR 0.41, 95% CI 0.23–0.74  PP/control 10.8%/28.1% I <sup>2</sup> 68% (P = 0.003) OR 0.33 95% CI 0.16–0.69 RR 0.41 95% CI 0.22–0.76  PP/control 6.9%/46.2% I <sup>2</sup> 67% (P < 0.0001) OR 0.10 95% CI 0.04–0.28	The results of this meta-analysis show that PP significantly reduces the incidence of AF and supraventricular arrhythmias after CABG  Reduction in the incidence of arrhythmias was associated with a significant reduction in the incidence of pericardial effusion Pericardial effusion was defined as significant if maximum diastolic separation between pericardium and epicardium was less than 1.0 cm  The authors of the meta-analysis criticize the methodology of the existing studies:  - method of randomization was reported in only two studies - Information regarding allocation concealment, blinding and incomplete outcome data was not reported

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Table 1: Continued

Author, date, journal, country Study type (level of evidence)	Patient group	Outcome measures	Key results	Comments
			RR 0.17 95% CI 0.07–0.42	- No data were reported regarding the use of drugs for AF prophylaxis, which represents a major bias for correct interpretation of these data
		Incidence of late pericardial effusion	PP/control 0%/11.3% $I^2$ 0% ( $P = 0.0001$ ) OR 0.04 95% CI 0.01–0.21 RR 0.05 95% CI 0.01–0.24	- A lack of data on postoperative haemodynamic instability, re-operation for bleeding/pericardial effusion and potential AF-related complications such as stroke, renal failure, prolonged length of in-hospital stay and re-admission
				The authors cautioned against the risks of cardiac herniation and bypass grafts trauma by the edge of the PP. They called for more detailed reports of the above potential problems

AF: atrial fibrillation; CABG: coronary artery bypass grafting; CI: confidence interval; COPD: chronic obstructive pulmonary disease; CPB: cardiopulmonary bypass; ECG: electrocardiography; LV: left ventricular; NS: not significant; OR: odds ratio; PP: posterior pericardiotomy; RR: risk ratio; SVT: supraventricular tachycardia.

Episodes of arrhythmia were counted only if they were refractory to correction of hypoxia and electrolyte imbalance. In this early study, a significant reduction in total arrhythmias and AF in the PP group (8 vs. 36% in the control group,  $P < 0.005$ ) was reported. Echocardiography was performed at set time points during the inpatient stay and demonstrated decreased incidence of pericardial effusion in the PP group. Furthermore, arrhythmia was significantly associated with the presence of pericardial effusion. The authors postulated that the presence of a pericardial effusion predisposed to postoperative arrhythmia. Important risk factors that are known to predispose to arrhythmia were not reported or controlled.

Asimakopoulos *et al.* [4] criticized the aforementioned study as not making any attempt either at randomization or at using standardized technique for cardiopulmonary bypass, myocardial protection or operative strategy. They performed a prospective randomized control trial of 100 patients. The results reported were from a single surgeon and operations were performed in a standardized manner. Contradictory to the findings of Mulay *et al.* [2], those of Asimakopoulos *et al.* [4] showed no significant difference in the incidence of arrhythmias between the groups. No echocardiography was performed in this study. The authors performed post-hoc analysis on their data and reported age as the strongest predictor of postoperative AF.

Kuralay *et al.* [5] performed a large prospective randomized controlled study. Operative techniques were well standardized and assessments of postoperative heart rhythm and pericardial effusion were comprehensive. The authors of this study were more selective and excluded patients with factors that may contribute to postoperative arrhythmia. Episodes of arrhythmia were recorded if they persisted beyond 30 min. The

incidence of AF was very significantly lower in the PP group. Furthermore, the authors reported very significantly reduced rates of early (<30 days) and late (>30 days) pericardial effusion in the PP group.

Farsak *et al.* [6] performed a study that was similar in its methodology to that by Kuralay *et al.* [5]. They included 150 patients who were randomly assigned to PP or a control group. They found the incidence of AF was significantly lower in the PP group. Farsak *et al.* [6] also demonstrated a reduced rate of early (<1 month) and late (>1 month) pericardial effusion in the PP group.

Arbatli *et al.* [7] performed a randomized controlled trial of 113 patients. They excluded patients with known risk factors for arrhythmia and described a standardized operative technique. Of note, the superior thymic fat was re-approximated and the inferior pericardium left open in this study. Episodes of AF or arrhythmia were counted if they lasted for more than 15 min. No significant difference in the rate of postoperative AF was demonstrated in this study between PP and control groups. Post-hoc analysis revealed that those with mild/moderate pericardial effusion had a greater incidence of AF than those with minimal effusion (29 vs. 10%,  $P = 0.017$ ).

In a randomized control trial of 100 patients by Ekim *et al.* [9], the incidence of AF was significantly lower in the PP group. The authors used a methodology similar to that used by Kuralay *et al.* [5]. The study was very selective in its inclusion criteria and standardized well the operative procedures performed. Analysis of the duration of postoperative inotropy revealed no difference between the groups. Episodes of AF were documented if they lasted for more than 20 min. The PP group also has significantly less early (<30 days) and late (>30 days) pericardial effusions.

Biancari and Mahar [10] performed a meta-analysis of the six aforementioned studies in accordance with the *Cochrane*

*Handbook for Systematic Reviews* [11]. They found that there was a highly significant reduction in total arrhythmias and AF in the PP group (odds ratio 0.31 and 0.33, respectively). The authors reported that reduction in the incidence of arrhythmias was associated with reduction in the incidence of pericardial effusion. There was a 10.8% AF rate in the PP group (41/379) and a 28.1% AF rate in the control group (108/384). The number needed to treat to prevent a case of AF was six.

Sperling *et al.* [12] performed a single-centre retrospective cohort study in 68 patients undergoing CABG (39 in PP and 29 in the control group). The incidence of AF was decreased by 66% in the PP group: it was 12.8% (5/39) in the PP group and 37.9% (11/29) in the control group. While the authors presented the work, we await formal publication of the data.

It should be noted that all these studies were performed only in patients receiving isolated on-pump CABG. The group studied was further refined as most authors excluded all patients with risk factors for arrhythmia. The authors of the meta-analysis were also critical of the methodological limitations of the existing trials as detailed in Table 1.

Bakhshandeh *et al.* [13] performed a prospective randomized controlled trial in 410 patients undergoing CABG alone or combined with valve surgery (205 in PP and 205 in the control group). At 15 and 30 days postoperatively, 90.2 and 97% of patients in the PP group were free of effusion whereas the entire control group had demonstrable pericardial effusion on echo.

Despite excellent influence of PP on postoperative AF and pericardial effusion there is some risk of haemodynamic instability and uncontrollable arrhythmias because of protruding venous grafts from the pericardiotomy side in patients undergoing CABG [6, 14].

In addition to the above, there are two guidelines that recommend PP to reduce postoperative AF with grade B strength of recommendation [15, 16].

## CLINICAL BOTTOM LINE

Postoperative AF is a complex phenomenon with multiple contributory factors. One such factor appears to be postoperative pericardial effusion. In a highly selective group (with minimal preoperative risk factors for AF), PP significantly reduces the incidence of postoperative AF and pericardial effusion (early and late). In this group, the number needed to treat to prevent one case of AF is six.

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