Can posterior pericardiotomy reduce the incidence of postoperative atrial fibrillation after coronary artery bypass grafting?

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OBJECTIVES: Atrial fibrillation (AF) is a common complication that increases the morbidity after open heart surgery. The pathophysiology is uncertain, and its prevention remains suboptimal. The aim of this study was to assess the efficiency of posterior pericardiotomy in decreasing the incidence of pericardial effusion and postoperative AF.

METHODS: This multicentre randomized prospective study included 200 patients who underwent open heart surgery; coronary artery bypass grafting procedure between June 2010 and May 2012. A posterior pericardiotomy incision was done in Group I (n = 100). A longitudinal incision, 4-cm long and 2-cm width, was made parallel and posterior to the left phrenic nerve, extending from the left inferior pulmonary vein to the diaphragm. Group II constituted the control group (n = 100). Postoperative pericardial effusion was assessed by echocardiography and rhythm follow-up was monitored daily.

RESULTS: The incidence of postoperative AF was significantly lower in the posterior pericardiotomy group than in the control group (13 vs 30%, P = 0.01). The number of patients with remarkable postoperative pericardial effusion was significantly lower in the posterior pericardiotomy group (15 vs 50 patients, P = 0.04). Tamponade developed in 3 patients in Group II (P = 0.07). There was a significantly higher incidence of chest drainage in the posterior pericardiotomy group than in the control group (1041 ± 549 vs 911 ± 122 ml; P = 0.04). There was no significant difference between the two groups regarding hospital stay (8 vs 9 days, P > 0.05).

CONCLUSIONS: Posterior pericardiotomy is a simple, safe and effective method for reducing the incidence of postoperative pericardial effusion and related atrial fibrillation by improving pericardial drainage after coronary artery bypass grafting.

Keywords: Atrial fibrillation • Coronary artery bypass grafting • Posterior pericardiotomy • Pericardial effusion

INTRODUCTION

Postoperative atrial fibrillation (POAF) is a common complication after open heart surgery. Its incidence varies from 30% after coronary artery bypass grafting (CABG) to 40% after valve replacement or repair, and increases to 50% after combined procedures. It usually occurs within 1–5 days after the operation, with a peak incidence on the second postoperative day [1]. Although it is usually a benign problem and well tolerated, it can be a life-threatening problem with significant morbidity and mortality. It can cause haemodynamic instability with prolonged hospital stay and increased costs [2]. Furthermore, the impact of POAF on hospital resources is significant.

Many aetiological factors have been identified in the development of POAF such as age, atrial dilatation, hyperthyroidism, left ventricular aneurysm, additional valve surgical procedures, perioperative myocardial infarction, postoperative low cardiac output, renal failure, respiratory complications and recently, pericardial effusion [3]. The incidence of postoperative pericardial effusion may reach up to 85% after cardiac surgery [4]. It is often small and benign, but can be circumferential and quite large and may interfere with cardiac filling causing tamponade. Chest tubes help the drainage of the anterior effusions but posterior ones become localized and loculated, causing mechanical irritation of the left auricle and helping in the development of atrial arrhythmias. Many studies demonstrated that posterior pericardiotomy could drain freely into the left pleural space, thereby reducing the prevalence of pericardial effusion and hence the development of AF [5–7]. The aim of this multicentre prospective, randomized study was to assess the efficacy of posterior pericardiotomy in
decreasing the incidence of postoperative AF by improving peri-
cardial drainage.

PATIENTS AND METHODS

This is a multicentre prospective randomized study that was con-
ducted on 200 patients who underwent an elective CABG opera-
tion between December 2008 and May 2012 in cardiac surgery
departments at Tanta University, Suez Canal University and
National Heart Institute, Egypt. After approval of the ethical re-
search committee in each institution, every patient gave informed
consent. The patients fulfilled the inclusion criteria and were ran-
domized into two equal groups (Groups I and II). Posterior per-
cardiomy was performed in Group I but not in Group II. Simple
randomization was done by creating a random digit: even
numbers went for the intervention group (posterior pericardiomy),
whereas odd numbers went for the control group.

Patients with previous AF or on anti-arrhythmic drugs, with
severe left ventricular dysfunction (EF ≤30%), chronic obstructive
pulmonary disease, renal impairment, hyperthyroidism, redo and
emergency CABG and patients with combined cardiac procedures
were excluded from the study to obviate disorders that could be
associated with an increased incidence of AF. All of the patients in
both groups had preoperative β-blockers as part of their anti-
ischaemic treatment.

Anaesthetic medication and surgical techniques were similar in
both groups. With the patient in supine position, full median ster-
notomy was done. The left pleural space was opened while mobil-
izing the left internal thoracic artery (LITA). The cardiopulmonary
bypass was established by cannulation of the ascending aorta and
the right atrium (double-stage, single cannula), moderate haemo-
dilution (haematocrit, 20–26%) and moderate systemic hyperther-
ia (28–32°C) using a roller pump, a non-pulsatile flow between
2.0 and 2.4 l/m²/min and a membrane oxygenator. The activated
clotting time was maintained more than 480 s. The mean arterial
pressure was maintained at 50–70 mmHg. Cold blood cardiople-
gia was given through antegrade cardioplegia cannula that was
inserted in the aortic root.

The distal anastomoses were constructed during a single period
of total aortic occlusion, whereas the proximal anastomoses were
performed on side occlusion clamp. The LITA was used in all
patients. In Group I, a longitudinal incision, 4-cm long and 2-cm
width, was made parallel and posterior to the left phrenic nerve,
extending from the left inferior pulmonary vein to the diaphragm
(Fig. 1). Two chest tubes (one in the left pleural cavity and the
second in the anterior mediastinum) were inserted and the peri-
cardium was left open anteriorly in both groups. No retrocardiac
tubes were placed to avoid mechanical irritation of the heart.
Heparin was reversed by protamine sulphate (1 : 1) at the end
of cardiopulmonary bypass.

After routine closure of the chest and in the ICU, the drains
were milked and stripped at 30-min intervals to ensure tube
patency. The amount of blood drainage was measured and
recorded every hour. The chest tubes were removed when the
drainage became less than 50 cc/12 h in any day after the day of
the operation. No prophylactic anti-arrhythmic drugs were given
to any patient postoperatively.

Continuous ECG monitoring was provided in the first 5 post-
operative days, and subsequently continuous monitoring was rein-
stituted whenever an arrhythmia was suspected, if there were any
changes in the heart rate or when the patient complained of
palpitation. The patient was considered to have POAF when an
episode of AF persisted longer than 30 min even after correction
of hypoxia and electrolyte imbalance. Postoperative anti-arrhythmic
drugs were not given routinely. Potassium and magnesium sup-
plements were given as necessary to maintain electrolyte balance
within the normal range (serum potassium level was corrected if
less than 4.5 mmol/l and serum magnesium level was corrected if
less than 1.0 mmol/l).

Two-dimensional echocardiography was done to assess the
presence of any pericardial effusion on the third and fifth post-
operative days and before discharge. Any effusion greater than 1
cm was considered significant. Additionally, echocardiographic
examinations were also performed after discharge to detect late
effusions and tamponade.

Statistical analysis

The collected data were organized, tabulated and statistically ana-
lysed using the SPSS software version 19 (statistical package for
social studies). For numerical data, the mean and standard devi-
ation were calculated. For independent samples, t-test was used for
comparing of mean values between studied groups after testing
for normal distribution of the data that were found to suffer no
kurtosis or skewness. For categorical data, the number and percent-
age distribution were calculated and differences in observation
between groups were tested using the χ² test. When χ² was not
found appropriate due to expected values of <5, Fisher’s exact test
was used instead. The level of significance was set at P <0.05.

RESULTS

There was no difference between the two groups in regard to age,
sex, LV ejection fraction, preoperative medications, functional
class, preoperative risk factors and previous myocardial infarction.

Figure 1: The posterior part of the pericardium following posterior pericardiot-
omy. The heart has been lifted to expose the posterior pericardium.
The numbers of the grafts, ischaemic and total bypass times were also comparable in both groups with no significant difference (Table 1).

Forty-three patients (21.5%) developed POAF. Total number of POAF was significantly less common in Group I (13 vs 30 patients, \( P = 0.01 \)). All POAF was seen in the first 5 days after the operation, with the peak incidence on the second postoperative day. Eighteen patients (41.9%) were younger than 60 years and 25 (58.1%) were older than 60 years with no significant difference. The time for the development of POAF was longer in Group I (1.85 ± 0.62 vs 1.12 ± 0.25 days, \( P = 0.15 \)) and the time elapsed for the response to anti-arrhythmic drugs—with returning to sinus rhythm—was significantly shorter (1.54 ± 0.10 vs 3.66 ± 0.86 days, \( P = 0.01 \)). All patients who had developed POAF in both groups received medical treatment in the form of amiodarone infusion. In Group I, 11 patients (84.6%) regained sinus rhythm, whereas in Group II only 9 patients (30%) regained sinus rhythm. This difference was statistically significant (\( P = 0.007 \)). Although it was not statistically significant, the need for positive inotropes was lower in Group I (17 vs 21 patients; Table 2).

POAF was also significantly more commonly associated with the presence of pericardial effusion (33 of 68 patients with pericardial effusion vs 10 of 132 patients with no pericardial effusion, \( P < 0.0001 \)).

The posterior pericardiectomy group (Group I) had significantly greater total pleural drainage (1041 ± 549 vs 911 ± 122 ml; \( P = 0.04 \)) and the time of drainage was significantly longer in Group I (29.6 ± 5.9 vs 22.1 ± 3.0 h; \( P = 0.04 \)).

There was a statistically significant difference in postoperative pericardial effusion. In Group I, the number of patients who did not have pericardial effusion was significantly more than in Group II (100 patients) \( P = 0.07 \). Although it was not statistically significant, the need for positive inotropes was lower in Group I (7 vs 9 days; \( P > 0.05 \)).

Three patients underwent reoperation in Group II: 1 patient of the dominant factors promoting the development of AF postoperatively [12]. Farsak et al. [5] reported that the increased age played an important role in promoting postoperative supraventricular tachycardia (SVT) where in their two groups the combined incidence of SVT was 7 of 64 patients (10.9%) younger than 60 years old and 24 of 86 patients (27.9%) older than 60 years (\( P = 0.014 \)). In contrast, our results demonstrated that the age was not a significant factor in the development of POAF as 41.9% of our patients with POAF were younger than 60 years and 58.1% were older than 60 years with no significant difference. Previous reports demonstrated a strong correlation between the presence of pericardial effusion and the higher incidence of supraventricular arrhythmias [4, 13, 14]. We also had a significantly higher incidence of POAF with patients with pericardial effusion than those without (48.5 vs 7.5%). Angelini et al. [13] solved the problem.

### Table 1: Demographic, preoperative and intraoperative data of the two groups

<table>
<thead>
<tr>
<th></th>
<th>Group I (100 patients)</th>
<th>Group II (100 patients)</th>
<th>Test of sig</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>54.3 ± 8.6</td>
<td>56.9 ± 7.7</td>
<td>t = 1.319</td>
<td>0.189</td>
</tr>
<tr>
<td>Sex (M/F)</td>
<td>64/36</td>
<td>68/32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LV function</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good (EF &gt;50%)</td>
<td>87</td>
<td>82</td>
<td>x2 = 0.950</td>
<td>0.329</td>
</tr>
<tr>
<td>Moderate</td>
<td>13</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(EF = 30–50%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>48 (48%)</td>
<td>46 (46%)</td>
<td>x2 = 0.080</td>
<td>0.777</td>
</tr>
<tr>
<td>Hypertension</td>
<td>56</td>
<td>54</td>
<td>x2 = 0.080</td>
<td>0.777</td>
</tr>
<tr>
<td>Smoking</td>
<td>55</td>
<td>54</td>
<td>x2 = 0.020</td>
<td>0.887</td>
</tr>
<tr>
<td>Previous MI</td>
<td>17%</td>
<td>14%</td>
<td>x2 = 0.340</td>
<td>0.558</td>
</tr>
<tr>
<td>No. of grafts</td>
<td>2.7 ± 0.6</td>
<td>2.6 ± 0.4</td>
<td>t = 1.387</td>
<td>0.167</td>
</tr>
<tr>
<td>IT (min)</td>
<td>54.5 ± 20.5</td>
<td>59.2 ± 16.5</td>
<td>t = 1.786</td>
<td>0.076</td>
</tr>
<tr>
<td>TBT (min)</td>
<td>86.8 ± 28.6</td>
<td>86.9 ± 22.9</td>
<td>t = 0.464</td>
<td>0.643</td>
</tr>
</tbody>
</table>

Values are means ± SD or number (%) where shown. EF: ejection fraction; MI: myocardial infarction; IT: ischaemic time; TBT: total bypass time.

### Table 2: Postoperative data of the two groups

<table>
<thead>
<tr>
<th></th>
<th>Group I (100 patients)</th>
<th>Group II (100 patients)</th>
<th>Test</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>POAF</td>
<td>13%</td>
<td>30%</td>
<td>( x^2 = 8.560 )</td>
<td>0.003*</td>
</tr>
<tr>
<td>Total drainage (ml)</td>
<td>1041 ± 549</td>
<td>911 ± 122</td>
<td>t = 2.312</td>
<td>0.022*</td>
</tr>
<tr>
<td>Tamponade</td>
<td>15%</td>
<td>53%</td>
<td>( x^2 = 32.170 )</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Positive inotrope</td>
<td>17</td>
<td>21</td>
<td>( x^2 = 0.520 )</td>
<td>0.471</td>
</tr>
<tr>
<td>IABP</td>
<td>1</td>
<td>1</td>
<td>FE</td>
<td>0.246</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>8</td>
<td>9</td>
<td>( x^2 = 0.060 )</td>
<td>0.800</td>
</tr>
</tbody>
</table>

Values are means ± SD or number (%) where shown. *: Significant and the level of significance was adopted at <0.005. FE: Fisher’s exact test; POAF: postoperative atrial fibrillation; IABP: intra-aortic balloon pump.
of postoperative supraventricular arrhythmias by evacuation of pericardial effusion and a subsequent sinus rhythm. In agreement, Mulay et al. [6] reported that posterior pericardiotomy reduced both the pericardial effusion and related POAF (8 vs 36%).

In our series, the posterior pericardiotomy significantly reduced POAF ($P = 0.01$). Similarly, Farsak et al. [5] and Kuralay et al. [7] also reported significantly lower incidence of AF in the posterior pericardiotomy group. In contrast, Arbatly et al. [11] and Asimakopoulos et al. [15] demonstrated that posterior pericardiotomy was more effective in draining the pericardial effusion, but the incidence of POAF was not significantly reduced compared with their control group (20 vs 26%).

In our study, although the time elapsed for the occurrence of POAF was not significantly longer in the posterior pericardiotomy group, the time for response to anti-arrhythmic drugs with returning to sinus rhythm was significantly shorter than the conventional group. Farsak et al. [5] also reported that the time elapsed for the development, response to medication and reoccurrence of POAF was significantly different in favour of their posterior pericardiotomy group. Asimakopoulos [15] had lower POAF in both their groups with no difference and they explained that by the use of β-blockers in all patients.

Although Asimakopoulos et al. [15] pointed out that pericardiotomy group had significantly higher incidence of pleural drainage, Farsak et al. [5], Arbatly et al. [11] and Kuralay et al. [7] did not find significantly increased chest drainage in their fenestration group. In our study, the pericardiotomy group had significantly greater pleural blood loss as expected and confirmed by follow-up echocardiography that showed this manoeuvre results in more effective pericardial drainage into the pleura. The increased drainage was not a result of bleeding from the pericardial incision as the edges were routinely checked for bleeding and cauterized.

We also revealed a significant decrease in the pericardial effusion in the posterior pericardiotomy group (15 vs 53%), whereas 3 patients developed tamponade in the conventional group. Mulay et al. [6] confirmed significantly less pericardial effusion in their fenestration group (8 vs 40%, $P < 0.001$) and concluded that pericardiotomy reduced the incidence of pericardial effusions and SVT. Farsak et al. [5] also had significantly increased posterior pericardial effusion in their conventional group (10.6 vs 42.6%, $P < 0.0001$).

There was no significant difference between the two groups regarding hospital stay (8 vs 9 days, $P > 0.05$). This is similar to that of Farsak et al. [5] who reported similar hospital stay in both their groups (7 vs 8 days, $P > 0.05$).

Although it was not statistically significant, the need for positive inotropes after surgery was lower in Group I (17 vs 21%). The same results obtained by the Farsak group [5] who reported the use of positive inotropy in (18.6 vs 22.6%), and Ekim et al. [16] also found no difference between their two groups (12 vs 14%).

We did not face any postoperative complications because of the posterior pericardiotomy incision, but it is not without complication as Yorgancioglu et al. [17] experienced a problem of haemodynamic instability and uncontrollable arrhythmias due to protrusion of a sequential graft through the posterior pericardiotomy opening.

CONCLUSION

Posterior pericardiotomy is an easy safe technique with no significant encountered complications. It significantly reduces the incidence of POAF and pericardial effusion in patients undergoing coronary artery bypass surgery.

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Conflict of interest: none declared.

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