Correlation between Preoperative Pulmonary Artery Pressure and Postoperative Atrial Fibrillation in Patients Undergoing Cardiac Surgery

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Abstract

Background: Atrial fibrillation (AF) is the most common arrhythmia to occur after cardiac surgery. The incidence of post-operative atrial fibrillation (POAF) has been reported to range from 10 to 65%. It is associated with increased morbidity, mortality, longer hospital stay and increased costs. A number of studies have examined the predictors of POAF. There have never been any studies evaluating the correlation between pre-operative pulmonary artery pressure (PAP) and the incidence of POAF.

Objective: This study aims to prospectively assess pre-operative mean PAP as a predictor of POAF.

Methods: One hundred and nine consecutive elective cardiac surgery patients were enrolled. Baseline demographic data were obtained. A Swan-Ganz catheter was inserted before beginning the cardiac operation. The PAP was recorded before induction of general anesthesia. Holter-monitoring was performed for 72 hours after the cardiac surgery. The primary endpoint was the overall occurrence of POAF.

Results: Overall POAF occurred in 29 (26.6%) of the 109 patients. Compared to patients with no POAF, the patients who developed POAF had larger left atrial sizes (4.2 ± 0.4 versus 3.7 ± 0.4 cm, p<0.001). There were no differences in baseline characteristics. Mean PAP levels in POAF patients were significantly higher than those in non-POAF patients (21.84 ± 6.71 versus 18.6 ± 5.46 mmHg, p = 0.012). The patients who had mean PAP levels in the highest quartiles (mean PAP ≥ 22.5 mmHg) were five times more likely to have POAF, compared to those with the lowest quartiles (mean PAP < 15 mmHg) (p = 0.012). The length of stay and total costs of treatment were significantly higher in POAF patients (12 ± 4 versus 10 ± 3 days, p < 0.001; 199,215 ± 31,435 versus 169,176 ± 17,272 baht; p < 0.001)

Conclusions: Preoperative PAP level is a good predictor of POAF. Measurement of mean PAP levels in patients undergoing cardiac surgery is useful in identifying patients at risk for POAF.

Key Words: Pulmonary artery pressure, atrial fibrillation

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Introduction

Cardiac arrhythmias are frequent post-operative complications of both cardiac and non-cardiac surgery (1). Post-operative atrial fibrillation (POAF) is the most common arrhythmic complication encountered after cardiac surgery. The incidence of POAF reported in previous studies varies from 10% to 65% (2-3). The reported incidence range is wide because the studies differ in baseline patient characteristics, types of surgery, methods of detection and the definitions of atrial fibrillation (AF) (3). There is lower incidence of AF in patients undergoing only coronary artery bypass grafting (CABG) compared with those undergoing valve surgery or combined CABG-valve operations. The incidence of AF in the general population is strongly age-dependent. The highest incidence
of AF tends to occur within 2 to 4 days after the procedure, with a peak incidence on post-operative day 2.

The mechanism of POAF is complex and not fully understood, but almost certainly multifactorial (4). The electrophysiologic mechanism of POAF is believed to be reentry that results from dispersion of atrial refractoriness. When adjacent atrial areas have dissimilar or non-uniform refractoriness, a depolarizing wavefront becomes fragmented as it encounters both refractory and excitable myocardium. This allows the wavefront to return and stimulate previously refractory but now repolarized myocardium, leading to incessant propagation of the wavefront or reentry (5-7). There is no adequate explanation why some patients develop POAF, whereas others having the same surgical interventions remain in sinus rhythm. It has been proposed that patients who are vulnerable to AF and develop POAF may already possess an electrophysiologic substrate for this arrhythmia before surgery (5). An alternative explanation is that this substrate is created as a result of the incision of the atrial or perioperative ischemia may increase cardiac susceptibility to rhythm disturbances (8).

Some causative mechanisms that have been proposed include pericardial inflammation, excessive production of catecholamines, autonomic imbalance and pharmacologic agents. It is well known that neurohormonal activation and enhanced sympathetic nervous system activity increases susceptibility to POAF (9-11). Post-operative pain and surgical complications, such as anemia, fever, hypoglycemia, and ischemia may also contribute to POAF (12). In a recent study obesity and metabolic syndrome were associated with a higher cardiac output requirement, higher left ventricular mass, and larger left atrial size that might predispose to the development of POAF (13).

Post-operative AF, especially after cardiac surgery, is associated with an increased mortality, morbidity and increased costs of post-operative care (14). It could lengthen hospitalization by approximately 2 days (15). There was a report that AF increased the hospital stay after cardiac surgery by an average of 1.4 days at an additional cost of 6,556 USD (14). The clinical presentation of AF can be highly variable (16). There are many sequelae of AF that include post-operative thromboembolic risk and stroke (17), hemodynamic compromise (18), ventricular dysrhythmias (19) and complications associated with therapeutic interventions. The risk for perioperative stroke is approximately threefold higher for patients with POAF. If AF is recurrent or prolonged more than 48 hours, there is a certain risk of cardioembolic stroke which leads to significant morbidity. In patients with ischemic heart disease, the loss of the atrial component may lead to a 25-50% decrease in cardiac output and blood pressure and may further lead to cardiac events (20). Moreover, POAF can be life threatening, particularly in the elderly and those with left ventricular dysfunction and thus associated with significant morbidity (21) and mortality (22). Finally, acute and post-discharge anticoagulation is important and there is a substantial risk of complications from this treatment strategy.

The detection and prevention of AF is a reasonable clinical goal and consequently several studies proposed many factors predictive for the development of AF after cardiac surgery. The most consistent predictor for the development of POAF is advanced age (22-24). It is well documented that advanced age is associated with degenerative and inflammatory modifications in atrial anatomy which lead to atrial dilation, atrial fibrosis and cause alterations in atrial electrophysiological properties (25). In addition to old age, many other risk factors in the development of POAF have been identified, including a previous history of AF, male gender, decreased left ventricular ejection fraction, left atrial enlargement, valvular heart surgery, chronic obstructive pulmonary disease, chronic renal failure, diabetes mellitus and obesity (13, 22, 26-28). However, there are many patients who had no risk factors but still developed POAF. There may be other predictors contributing to POAF.

The pulmonary artery catheter (PAC) or Swan-Ganz catheter is used in an invasive hemodynamic monitoring procedure that provides important clinically relevant hemodynamic data in selected patients, especially, those with shock or unclear hemodynamics and poor response to therapy, as well as those patients undergoing cardiac surgery. Pulmonary artery pressure (PAP) as obtained from PAC insertion allows measurement and analysis of right atrial, right ventricular, pulmonary artery, and pulmonary capillary wedge pressures (PCWP), measurement of cardiac output by thermodilution and
Correlation between Preoperative Pulmonary Artery Pressure and Postoperative Atrial Fibrillation in Patients Undergoing Cardiac Surgery

screening for intracardiac shunts. Normal mean PAP is about 15 mmHg (29).

The pulmonary artery catheter is the standard procedure for hemodynamic monitoring during cardiac operations at Phramongkutklao Hospital. It is inserted before the beginning of the operation by the anesthesiologist and the PAP level is measured and recorded on the operative sheet before inducing general anesthesia. It is used mainly to monitor the volume status by measuring PCWP which indirectly reflect the left ventricular preload or left ventricular end diastolic pressure (LVEDP). The value of PAP obtained when the PAC is inserted has never been considered by both the surgeon and the anesthesiologist to have any clinical value. By randomly reviewing the operating notes in 2006, we found no record of a PAP value in any of the operative notes.

Very few data are available regarding the relationship of mean PAP and POAF. One retrospective data analysis study showed that patients with AF had higher levels of mean PAP than those in sinus rhythm especially in valvular heart disease patients (30). To date, there has never been a prospective study evaluating the correlation between pre-operative PAP and the incidence of POAF.

Therefore, this study aims to assess pre-operative mean PAP level as a predictor of POAF in a prospective cohort study in consecutive patients who underwent open cardiac surgery.

Methods

Patients

The patients participating in this study were 18 years and older and scheduled for elective open heart surgery. The patients were included consecutively according to the elective cardiac surgery list of the Division of Thoracic surgery, Phramongkutklao Hospital from January 1, 2007, to December 31, 2007. The exclusion criteria consisted of the following: (1) recent heart failure within 60 days (2) recent acute coronary syndrome (including unstable angina (UA)/non ST elevation myocardial infarction (NSTEMI)/ST elevation myocardial infarction (STEMI)) within 60 days (3) previous history of atrial arrhythmia (4) previous use of anti-arrhythmic drugs of class I and III (5) implanted permanent pacemaker (6) emergency surgery (7) hyperthyroidism and (8) not signing the informed consent. The study protocol was approved by the Phramongkutklao Hospital Research Ethics Committee. The written informed consent was obtained from each of the participants.

Study Design and Protocol

This research was a prospective, cohort analysis study, designed to determine the correlation between the mean PAP level and the incidence of POAF. The patients enrolled in the study had a blood sample drawn for routine preoperative blood chemistry check. The thyroid function test was also done at the same time. Data of presurgical electrocardiograms (ECGs) and transthoracic echocardiograms were collected. The investigators reviewed the participants’ medical history, history of medication usage and did the physical examination, preoperatively. The pulmonary artery catheter was inserted to measure PAP by the anesthesiologist before the beginning of surgery. The value of the PAP level at steady state was recorded. The Holter monitoring device was attached to each of the patients as soon as the subject came out of the operating room for 72 hours and they were analyzed within 72 hours of the post-operative period. The 12-lead ECGs were obtained when necessary to confirm rhythm abnormalities and the data were checked daily. Atrial fibrillation was defined according to ACC/AHA/ESC Practice Guidelines 2006 as replacement of consistent P waves by rapid oscillations or fibrillatory waves that vary in amplitude, shape, and timing, associated with an irregular, frequently rapid ventricular response when atrioventricular (AV) conduction is intact (31). The primary endpoint was the overall occurrence of the POAF. This study was not sponsored by any company. The funding was partially from the Phramongkutklao Hospital Medical Department Research Fund.

Follow-up

The patients were followed up at 30 post-operative days. Death was identified through the hospital-based patient-information and death certificates. Death from any cause was defined as any death during the follow-up. Death from a cardiac cause was defined as death from any cardiac cause (e.g. lethal arrhythmia, acute myocardial infarction, pumping failure, or sudden cardiac death). The patients were followed up at the cardiovascular thoracic surgery outpatient clinic or by telephone in case the subjects did not come to the clinic. Patients who were not confirmed to
have died and who had no follow-up information were deemed lost to follow-up.

**Statistical analysis**

Descriptive analysis was performed. Univariate characteristics between patients with and without AF were analyzed with the Chi-Square test or Fisher’s exact test for categorical data, and unpaired T test or Mann-Whitney U test for continuous data, both with the power of significance at alpha 0.05. Continuous variables are presented as mean (SD) or median (IQR). The results of mean PAP were divided as percentiles and also into quartiles, for the latter a multiple logistic regression method was used. Results are adjusted for a variety of parameters with the use of multivariate analysis by backward stepwise multiple logistic regressions. The mean PAP values were then used to compute an adjusted Receiver-operator characteristics (ROCs) curve, with the area under curve (AUC) as an indicator of overall discrimination. Statistical analysis was performed with the use of SPSS software, version 15.0.

**Results**

A total of 115 patients were scheduled for cardiac surgery. One hundred and nine patients were enrolled into the study. Six were excluded, one because of recent heart failure, one because of previous AF, two because of recent acute coronary syndrome, one because of emergency surgery and one because of previous use of anti-arrhythmic drugs. Of one hundred and nine patients, one hundred and two patients underwent coronary artery bypass surgery, seven patients underwent other cardiac surgery (two patients had undergone CABG combined aortic valve replacement, two CABG combined mitral valve replacement, one aortic valve replacement combined mitral valve replacement, one aortic valve replacement, and one mitral valve replacement) (Figure1).

Table 1 shows the patients’ baseline characteristics and treatments. Overall POAF occurred in 29 (26.6%) of the 109 patients. The distributions of the underlying diseases such as diabetes mellitus, dyslipoproteinemia, history of previous myocardial infarction, functional class, current

**Figure 1.** Scheme of enrollment
## Table 1. Baseline characteristics and treatments of patients

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total n = 109 (%)</th>
<th>POAF n = 29 (%)</th>
<th>No POAF n = 80 (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>64 ± 16</td>
<td>66 ± 12</td>
<td>63 ± 19</td>
<td>0.259</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>97 (69.7)</td>
<td>24 (82.3)</td>
<td>73 (91.3)</td>
<td>0.297</td>
</tr>
<tr>
<td>Female</td>
<td>12 (30.3)</td>
<td>5 (17.7)</td>
<td>7 (8.7)</td>
<td>0.312</td>
</tr>
<tr>
<td><strong>Underlying diseases</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>76 (69.7)</td>
<td>22 (75.9)</td>
<td>54 (67.5)</td>
<td>0.401</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>40 (36.7)</td>
<td>3 (27.6)</td>
<td>32 (40.0)</td>
<td>0.235</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>24.4 ± 3.4</td>
<td>25.6 ± 3.7</td>
<td>23.9 ± 3.2</td>
<td>0.021</td>
</tr>
<tr>
<td>Dyslipoproteinemia</td>
<td>37 (33.9)</td>
<td>8 (27.6)</td>
<td>29 (36.3)</td>
<td>0.399</td>
</tr>
<tr>
<td>Previous MI</td>
<td>27 (24.3)</td>
<td>7 (24.1)</td>
<td>20 (25.0)</td>
<td>0.927</td>
</tr>
<tr>
<td><strong>Tobacco use</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>9 (8.3)</td>
<td>0</td>
<td>9 (11.3)</td>
<td>0.109</td>
</tr>
<tr>
<td>Non-smoker</td>
<td>100 (91.7)</td>
<td>29 (100)</td>
<td>71 (90.7)</td>
<td>0.135</td>
</tr>
<tr>
<td><strong>Functional class</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>91 (83.5)</td>
<td>26 (89.7)</td>
<td>65 (81.2)</td>
<td>0.389</td>
</tr>
<tr>
<td>2</td>
<td>18 (16.5)</td>
<td>3 (10.3)</td>
<td>15 (18.8)</td>
<td>0.412</td>
</tr>
<tr>
<td><strong>Surgical type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CABG</td>
<td>102 (93.6)</td>
<td>74 (92.5)</td>
<td>28 (96.6)</td>
<td>0.672</td>
</tr>
<tr>
<td>Others</td>
<td>7 (6.4)</td>
<td>6 (7.5)</td>
<td>1 (3.4)</td>
<td>0.412</td>
</tr>
<tr>
<td><strong>Medications</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspirin</td>
<td>75 (68.8)</td>
<td>20 (69.0)</td>
<td>55 (68.8)</td>
<td>0.983</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>42 (38.5)</td>
<td>11 (37.9)</td>
<td>31 (38.8)</td>
<td>0.938</td>
</tr>
<tr>
<td>B-blocker</td>
<td>65 (59.5)</td>
<td>17 (58.6)</td>
<td>48 (60.0)</td>
<td>0.897</td>
</tr>
<tr>
<td>ACEI</td>
<td>42 (38.5)</td>
<td>13 (44.8)</td>
<td>29 (36.3)</td>
<td>0.416</td>
</tr>
<tr>
<td>ARB</td>
<td>18 (16.5)</td>
<td>6 (20.7)</td>
<td>12 (15.0)</td>
<td>0.561</td>
</tr>
<tr>
<td>CCB</td>
<td>17 (15.6)</td>
<td>5 (17.2)</td>
<td>12 (15.0)</td>
<td>0.771</td>
</tr>
<tr>
<td>Diuretic</td>
<td>18 (16.5)</td>
<td>8 (27.6)</td>
<td>10 (12.5)</td>
<td>0.080</td>
</tr>
<tr>
<td>Statin</td>
<td>83 (76.1)</td>
<td>24 (82.8)</td>
<td>59 (73.8)</td>
<td>0.329</td>
</tr>
<tr>
<td>Nitrate</td>
<td>29 (26.6)</td>
<td>9 (31.0)</td>
<td>20 (25.0)</td>
<td>0.529</td>
</tr>
<tr>
<td><strong>Laboratory data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hct (vol%)</td>
<td>37 ± 9.7</td>
<td>35 ± 8.5</td>
<td>37.8 ± 9.0</td>
<td>0.154</td>
</tr>
<tr>
<td>FBS (mg/dl)</td>
<td>107 ± 37.0</td>
<td>116 ± 49.0</td>
<td>102 ± 30.0</td>
<td>0.158</td>
</tr>
<tr>
<td>Creatinine (mg/dL)</td>
<td>1.1 ± 0.3</td>
<td>1.0 ± 0.6</td>
<td>1.1 ± 0.3</td>
<td>0.992</td>
</tr>
<tr>
<td>K+ (mEq/L)</td>
<td>4.1 ± 0.5</td>
<td>4 ± 0.4</td>
<td>4.1 ± 0.5</td>
<td>0.351</td>
</tr>
<tr>
<td><strong>Echo data</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>57 ± 13</td>
<td>58 ± 14</td>
<td>57 ± 13</td>
<td>0.859</td>
</tr>
<tr>
<td>LA size (cm)</td>
<td>3.8 ± 0.4</td>
<td>4.2 ± 0.4</td>
<td>3.7 ± 0.4</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Mean PAP (mmHg)</td>
<td>19.4 ± 5.9</td>
<td>21.8 ± 6.7</td>
<td>18.6 ± 5.4</td>
<td>0.012</td>
</tr>
<tr>
<td>Operative time</td>
<td>5.5 ± 2.0</td>
<td>6 ± 1.5</td>
<td>5 ± 2.5</td>
<td>0.019</td>
</tr>
<tr>
<td>Bypass time (hrs)</td>
<td>2.0 ± 1.0</td>
<td>2.5 ± 1.0</td>
<td>2.0 ± 1.0</td>
<td>0.013</td>
</tr>
<tr>
<td>Time in ICU (hrs)</td>
<td>63.0 ± 24.0</td>
<td>72.0 ± 22.0</td>
<td>58.0 ± 23.0</td>
<td>0.003</td>
</tr>
<tr>
<td>Length of stay (days)</td>
<td>10.0 ± 4</td>
<td>12.0 ± 4</td>
<td>10.0 ± 3</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Total hospital costs (baht)</td>
<td>177,168 ± 25,539</td>
<td>199,215 ± 31,435</td>
<td>169,176 ± 17,272</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

POAF = post-operative atrial fibrillation; BMI = body mass index; MI = myocardial infarction; CABG = coronary artery bypass graft; ACEI = angiotensin converting enzyme inhibitor; ARB = angiotensin II receptor blocker; CCB = calcium channel blocker; Hct = hematocrit; FBS = fasting blood sugar; K+ = serum potassium; LVEF = left ventricular ejection fraction; LA = left atrium; PAP = pulmonary artery pressure; and ICU = intensive care unit
Table 2. Multivariable analysis to assess predictors of post-operative atrial fibrillation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA size (cm)</td>
<td>3.85</td>
<td>1.54 – 9.62</td>
<td>0.004</td>
</tr>
<tr>
<td>BMI</td>
<td>1.15</td>
<td>1.01 – 1.32</td>
<td>0.041</td>
</tr>
<tr>
<td>Mean PAP 50\textsuperscript{th} percentile (≥ 19 mmHg)</td>
<td>1.60</td>
<td>1.61 – 4.18</td>
<td>0.335</td>
</tr>
</tbody>
</table>

BMI = body mass index; LA = left atrium; PAP = pulmonary artery pressure

Table 3. Mean PAP levels in quartiles

<table>
<thead>
<tr>
<th>Quartile value</th>
<th>Range</th>
<th>OR</th>
<th>95% CI</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>≤ 15.00</td>
<td>1.0</td>
<td>0.44 – 7.38</td>
<td>0.405</td>
</tr>
<tr>
<td>Q2</td>
<td>15.00 – 19.00</td>
<td>1.81</td>
<td>0.45 – 7.38</td>
<td>0.608</td>
</tr>
<tr>
<td>Q3</td>
<td>19.10 – 22.49</td>
<td>1.43</td>
<td>0.35 – 5.76</td>
<td>0.012</td>
</tr>
<tr>
<td>Q4</td>
<td>≥22.50</td>
<td>5.34</td>
<td>1.45 – 19.64</td>
<td></td>
</tr>
</tbody>
</table>

smoking, surgical type and the distribution of drug use among the patients with and without POAF were similar. Mean PAP level in the group of POAF patients were significantly higher than the group of non-POAF patients (21.84 ± 6.71 versus 18.6 ± 5.46 mmHg, p = 0.012). As compared to patients without POAF, patients with POAF had significantly higher BMI (25.6 ± 3.7 versus 23.9 ± 3.2 kg/m\(^2\), p = 0.021) and larger left atrial dimension (4.2 ± 0.4 versus 3.7 ± 0.4 cm, p < 0.001) and a non-significant trend toward hypertension (75.9% versus 67.5%, p = 0.401).

Other factors such as hematocrit, creatinine and potassium levels three days after the operations were similar. Of interest, there was a trend toward longer intubation time and a significant longer operative time, longer cardiopulmonary bypass time, longer intensive care unit (ICU) stay, longer length of stay and higher hospital costs in patients with POAF. The ages in POAF and non-POAF were 66 ± 12 and 63 ± 19 (p = 0.259), respectively. The difference of left ventricular ejection fraction in the two groups was not statistically significant (58.4 ± 14 versus 57 ± 13, p = 0.859).

One patient died of sudden cardiac death a few hours after surgery. The mortality rate was 0.91%. This number was too low to evaluate the statistical significance.

In a multivariable logistic regression model adjusting for sex, age, type of surgery, hypertension, diabetes mellitus, functional class, drug use (β-blocker, angiotensin-converting enzyme inhibitors (ACEI), angiotensin receptor blockers (ARB) and statin), smoking history, left ventricular ejection fraction, left atrial size, BMI and mean PAP level, we found that left atrial size and BMI were associated with a higher risk for POAF. The mean PAP level in the upper 50\textsuperscript{th} percentile (≥ 19 mmHg) also showed...
a trend toward an association with a higher risk for POAF as shown in Table 2.

We also made an analysis of mean PAP levels as quartiles as shown in Table 3. We found that the mean PAP level in the fourth quartile was significantly predictive for POAF (odds ratio, 5.34; 95% CI, 1.451-19.646; p = 0.012).

The odds ratio (OR) of developing AF was increasing according to the mean PAP quartiles as showed in Figure 2.

The ROC curve was constructed to identify the cut off point of the mean PAP level that may be practical and easy to use as a predictor for POAF. The mean PAP level of 18 mmHg gives the highest sensitivity and specificity of 72% and 50%, respectively, in predicting POAF (Figure 3). The negative predictive value of the mean PAP level of 21.1 mmHg was 72.5%. The area under the curve (AUC) was 0.657.

Discussion

In this study, an elevated mean pulmonary artery pressure level obtained before cardiac surgery was a good predictor for POAF. The mean PAP levels correlated well with POAF. There was a level-response relationship between the increasing risk of POAF and the rising mean PAP levels. The mechanism for establishing the correlation between mean PAP level and AF was that left atrial pressure that can increase during surgery might be an inciting factor. So if the left atrial pressure is increased preoperatively, mean PAP may also rise, thus, predisposing patients to develop POAF. Another proposed mechanism is an abnormally large LA size.

Even in excluded high risk POAF patients, we still found that the overall incidence of POAF in this study was around 30%. It is similar to past reported studies (1-3). Many studies showed that POAF has been associated with greater morbidity and mortality, longer hospital stays and increased costs of post-operative care as well. Our study similarly showed that patients with POAF had significantly longer lengths of hospital stay and higher hospital costs than patients without POAF.

There are several advantages of using the mean PAP level as a predictor of POAF. First, PAC insertion is a standard procedure that is routinely used in all patients undergoing cardiac surgery in many centers. Second, the data will be recorded on the operative sheet so it always available for reviewing. Furthermore, in identifying patients at high risk for POAF in clinical practice by using mean PAP levels, we can give intervention and prevention in such cases.

The mean PAP level of 18 mmHg has sensitivity and specificity of 72% and 50%, respectively, for predicting POAF. Since it was not a high sensitivity and specificity but if combined with other predictors, it could provide better utility for the clinician. Furthermore, if we added others factors to the increased PAP such as congestive heart failure or pulmonary hypertension patients, it would give more sensitivity and specificity.

The limitation of this study was the inaccuracy of the PAP levels that depended on various uncontrolled factors. We controlled these confounding factors by excluding underlying diseases that affected the patients such as congestive heart failure, chronic lung disease, and other emergency conditions. However as much as we could control there were other uncontrolled factors that effect the PAP measurement such as individual PAP fluctuations or the measurement technique.
In anticipating possible POAF, the attending physician should be prepared for the events. Many studies have evaluated the effectiveness of pharmacologic and nonpharmacologic interventions to prevent or decrease the high incidence of POAF in general thoracic surgery. (15, 48-50). Recent guidelines on the prevention and management of POAF were published in 2006 by the American College of Cardiology, the AHA, and the European Society of Cardiology (32).

In prevention of POAF, \(\beta\)-blockers have the strongest evidence for use as prophylactic medications. Several clinical trials have evaluated the effect of various \(\beta\)-blockers on the incidence of POAF (33–35). In a recent meta-analysis, Crystal et al. found that \(\beta\)-blockers had the greatest magnitude of effect across 28 trials (4,074 patients) with an odds ratio (OR) of 0.35, 95% confidence interval (CI) 0.26 to 0.49 (36). In addition, Andrews et al. reported, in another meta-analysis of 24 trials limited to patients with ejection fraction > 30% undergoing CABG, prophylactic administration of \(\beta\)-blockers was associated with a protection against supraventricular tachycardia with an OR of 0.28, 95% CI 0.21 to 0.36 (10).

Amiodarone has been investigated as an aggressive alternative option to target POAF. The ARCH (Amiodarone Reduction in Coronary Heart) trial involving 300 patients found that post-operative intravenous administration of amiodarone (1 g daily for 2 d) reduced the incidence of POAF from 47% to 35% compared with placebo (p = 0.01) (37). In the PAPABEAR (Prophylactic Oral Amiodarone for the Prevention of Arrhythmias That Begin Early After Revascularization, Valve Replacement, or Repair) trial, in which a 13-d perioperative course of oral amiodarone (10 mg/kg daily beginning 6 d before and continuing for 6 d after surgery) was shown to significantly decrease the incidence of POAF (38).

Also prophylactic atrial pacing to prevent AF after heart surgery is used effectively. There are several mechanisms by which atrial pacing might prevent AF. Meta-analyses of these clinical trials have consistently shown that single-or dual-site atrial pacing significantly reduces the risk of new-onset POAF (39-41). Pretreatment with digoxin, verapamil (non-dihydropyridine calcium-channel blockers) and magnesium does not prevent POAF in many studies (10, 42-43).

Observational studies have previously suggested that patients under statin therapy have a lower incidence of POAF. Recently, the prospective randomized study ARMYDA-3 (Atorvastatin for Reduction of Myocardial Dysrhythmia After cardiac surgery) has demonstrated that treatment with atorvastatin 40 mg/day started 7 days before elective cardiac surgery significantly reduces the occurrence of POAF by 61% and shortens hospital stay (45).

Recent studies, Calo et al. in a randomized controlled trial of 160 patients undergoing elective CABG, found that N-3 polyunsaturated acids (PUFAs) supplementation significantly reduced the incidence of POAF (46).

Interestingly, in a recent multicenter trial (47) 241 consecutive patients undergoing cardiac surgery were randomized to receive either 100 mg hydrocortisone or a placebo. The incidence of POAF during the first 84 h was significantly lower in the hydrocortisone group (36 of 120 [30%]) than in the placebo group (58 of 121 [48%]).

Angiotensin-converting enzyme inhibitors and angiotensin II receptor blockers are known to reduce the incidence of AF in nonsurgical populations and are worthy of investigation in the context of POAF.

In SOLVD (the Montreal Heart Institute (MHI), included in the Studies Of Left Ventricular Dysfunction) trials, verified that ACEI enalapril markedly reduced the risk of development of AF in patients with left ventricular dysfunction with a hazard ratio of 0.22 (95%CI, 0.11 to 0.44, p < 0.0001) (51). This result may be applied to the post-operative condition.

Healey JS and co workers did the meta-analysis of prevention of AF with ACEI and ARB. Overall, ACEIs and ARBs reduced the relative risk of AF by 28% (95% CI, 15%-40%, p = 0.0002) (52).

Recently, a sub-study from LIFE (Losartan Intervention For Endpoint reduction in hypertension study) trial found that new-onset AF was significantly reduced by losartan, compared to atenolol-based antihypertensive treatment with similar blood pressure reduction in both groups (33% risk reduction) (53).

The Valsartan Heart Failure Trial (Val-HeFT) demonstrated that adding valsartan to prescribed therapy for heart failure significantly reduced the incidence of AF by 37% (54).
However, from our study the patients who took ACEIs, ARBs, calcium channel blockers or β-blockers were small in numbers that they could not give a power of statistical significance to detect properties in prevention of AF.

Treatment of POAF is similar to non-surgical AF patients, an immediate electrical cardioversion has to be performed for hemodynamically unstable patients. For those who are hemodynamically stable, an AV nodal blocking agent should be used to achieve the appropriate ventricular rate control. If AF does not spontaneously convert to sinus rhythm within 24 h, then a rhythm control strategy should be attempted with class III or IC antiarrhythmic drugs. Anticoagulation with heparin or oral anticoagulation is appropriate when AF persists longer than 48 hours (55-56).

Conclusions

This study demonstrated that the pre-operative pulmonary artery pressure level is a good predictor of post-operative atrial fibrillation. Measurement and evaluation of this parameter in patients undergoing cardiac surgery is useful in identifying patients at risk for post-operative atrial fibrillation, so prophylaxis strategies could be properly implemented.

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References

Correlation between Preoperative Pulmonary Artery Pressure and Postoperative Atrial Fibrillation in Patients Undergoing Cardiac Surgery


การศึกษาหาความสัมพันธ์ระหว่างระดับความดันเลือดในหลอดเลือดแดงปอด (pulmonary artery pressure) ก่อนผ่าตัดกับอุปัปชญการเกิดภาวะหัวใจเต้นผิดจังหวะแบบ atrial fibrillation หลังการผ่าตัดหัวใจ


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บทคัดย่อ:

วัตถุประสงค์: ภาวะหัวใจเต้นผิดจังหวะแบบ atrial fibrillation (AF) เป็นภาวะหัวใจเต้นผิดจังหวะที่พบบ่อยที่สุดหลังการผ่าตัดหัวใจพบได้ถึง 10-65% และถือว่าเป็นภาวะแทรกซ้อนที่สำคัญและสัมพันธ์กับการตายและทุพพลภาพที่เพิ่มขึ้น แต่การศึกษาหาความสัมพันธ์ระหว่างระดับความดันเลือดในหลอดเลือดแดงปอดก่อนผ่าตัดกับการเกิดภาวะหัวใจเต้นผิดจังหวะแบบ AF (post-operative atrial fibrillation, POAF) ยังไม่เคยมีการศึกษาหาความสัมพันธ์ระหว่างระดับความดันเลือดในหลอดเลือดแดงปอด (pulmonary artery pressure, PAP) ก่อนผ่าตัดกับอุปัปชญการเกิด POAF การศึกษาครั้งนี้จึงเป็นการศึกษาหาความสัมพันธ์ระหว่างการศึกษาหาความสัมพันธ์ของ PAP ก่อนการผ่าตัดกับอุปัปชญการเกิด POAF เวลาการศึกษา: มีผู้ป่วยเข้าร่วมการศึกษานี้ทั้งหมด 109 คน โดยทุกคนได้รับการใส้สายสวนหัวใจ (pulmonary artery catheter) เพื่อวัดความดันในหลอดเลือดแดงปอดก่อนการผ่าตัดหัวใจ และได้รับการติดตั้งเครื่องเพื่อตรวจคลื่นไฟฟ้าหัวใจ (Holter-monitoring) เป็นเวลา 72 ชั่วโมงหลังการผ่าตัด

ผลการศึกษา: พบอุปัปชญการเกิด POAF 29 คนจาก 109 คน คิดเป็นร้อยละ 26.6 โดยผู้ป่วยที่มี POAF มีค่าเฉลี่ยของระดับ PAP สูงกว่าผู้ป่วยที่ไม่มี POAF (21.84 ± 6.71 mmHg, p = 0.012) และมีค่าน้ำหนัก (body mass index) เท่ากัน (25.6 ± 3.7 และ 23.9 ± 3.2 kg/m², p = 0.021) นอกจากนี้ยังพบว่าผู้ป่วยที่มี POAF มีขนาดของหัวใจเอเตรียมซ้ายที่ใหญ่กว่า (4.2 ± 0.4 และ 3.7 ± 0.4 ซม., p < 0.001) และมีค่าตัวชี้น้ำหนัก (body mass index) เท่ากัน (25.6 ± 3.7 และ 23.9 ± 3.2 kg/m², p = 0.021) นอกจากนี้ยังพบว่าผู้ป่วยที่มี POAF ใช้เวลาในการผ่าตัด การใส้สายสวนหัวใจ และนอนใน ICU นานกว่า และระยะเวลาการรักษาในโรงพยาบาลและเสียหายศีกษาไข้ในการรักษาพยาบาลมากกว่า (12 ± 4 และ 10 ± 3 วัน, p < 0.001; 199,215 ± 31,435 และ 169,176 ± 17,272 บาท, p < 0.001) ตามลำดับ

สรุป: ระดับ PAP ก่อนผ่าตัดมีความสัมพันธ์กับอุปัปชญการเกิด POAF และสามารถใช้เป็นตัวชี้วัดการเกิด POAF ได้เป็นอย่างดี ฉะนั้น การวัดระดับ PAP จึงมีประโยชน์ในการพิจารณาการที่จะป้องกันและรักษาผู้ป่วยกลุ่มที่มีความเสี่ยงในการเกิด POAF ได้อย่างเหมาะสม