

## Predictive value of P-wave duration and dispersion in post coronary artery bypass surgery atrial fibrillation

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### Abstract

**BACKGROUND:** Atrial fibrillation (AF) is the most common complication of cardiac surgery. Although it is managed easily, it can cause critical hemodynamic instabilities for intensive care patients. This observational study investigated the predictive power of P-wave dispersion (PWD) for the incidence of post cardiac surgery AF.

**METHODS:** Among patients undergoing isolated coronary artery bypass grafting surgery (CABG), 52 patients were selected randomly. Before the operation, ejection fraction, regional wall motion abnormality, and mitral regurgitation were determined by echocardiography. Angiographic data provided information about stenosed vessels. PWD was measured before and after CABG. The incidence of post-CABG AF was determined by rhythm monitoring.

**RESULTS:** There were no significant differences in age, sex, stenosed vessels, maximum P-wave duration, the prevalence of hypertension, smoking, mitral regurgitation, and regional wall motion abnormality between post-CABG AF and non-AF groups ( $P > 0.05$ ). The mean prevalence of diabetes mellitus in post-CABG AF group was more than non-AF group ( $P = 0.036$ ). The mean ejection fraction in post-CABG AF group was lower than non-AF group ( $P < 0.005$ ). The mean PWD in AF group vs. non-AF group before CABG was 47.5 vs. 23.7 ms. The mean values of post-surgical PWD in AF and non-AF groups were 48.10 and 24.4 ms, respectively. Before CABG, the mean ejection fraction value and minimum P-wave duration in AF group were lower than non-AF group ( $P < 0.005$ ). A reverse relation was present between minimum P wave duration and PWD ( $P < 0.001$ ). There was a negative association between high ejection fraction values and decreased PWD ( $P = 0.002$ ).

**CONCLUSION:** Our data suggested minimum P wave duration, PWD, and low ejection fraction are as good predictors of AF in patients undergoing isolated CABG. The absence of differences in age, sex, smoking, hypertension, mitral regurgitation, and regional wall motion abnormality in our study was in contrast with other reports. On the other hand, increased rate of post-CABG AF in our diabetic patients with lower ejection fraction supports other studies. Overall, minimum P wave duration, PWD, and low ejection fraction can be used for patient risk stratification of AF after CABG.

**Keywords:** Atrial Fibrillation, Coronary Artery Bypass Grafting, P-Wave Dispersion, Predictor.

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### Introduction

Post cardiac surgery atrial fibrillation (AF) is common and often occurs between the second and fourth postoperative days.<sup>1</sup> Its incidence in isolated coronary artery bypass graft surgery (CABG) is estimated to be 11-40% which is lower than cases of valvular cardiac surgery.<sup>2</sup> Although post-CABG AF is often short-lived and self-limited, it is associated with significant increases in hemodynamic instability, thromboembolic events, neurological, renal, and infectious complications, and hospital length of stay. Frequency

of intensive-care unit readmission, perioperative myocardial infarction, ventricular arrhythmias, and persistent congestive heart failure are also increased.<sup>1,3-5</sup> Overall, the long-term mortality is increased about 29% in patients who developed early post-CABG AF.<sup>6</sup> Although this post-surgical complication is frequent, the underlying mechanisms are not well understood. Therefore, prevention of AF in high risk patients has been investigated to find the high risk group and predictors of post-CABG AF. Generally, advanced age, history of AF, withdrawal of  $\beta$ -blockers and

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angiotensin-converting-enzyme (ACE) inhibitors, congestive heart failure, electrolyte abnormalities (hypokalemia and hypomagnesemia), cardiopulmonary bypass, right atrial manipulation, left atrial dysfunction, neurohormonal activity, respiratory diseases, ventilation for more than 24 hours, previous CABG, and male gender have been considered as potential risk factors for development of multifactorial post-surgical AF.<sup>7-11</sup> Other predisposing factors include alterations in atrial refractoriness, local re-entry, atrial fibrosis, raised atrial pressure by postoperative ventricular stunning and fluid overload, increased atrial electrical susceptibility from rapid return of temperature after cardioplegic arrest, inotropic drugs, reflex sympathetic activation, pericardial complications, and inflammatory mechanisms.<sup>7,12</sup> In addition to these common risk factors, some specific predictors can be used for identification of patients at risk. Patients at risk of postoperative AF have prolonged echocardiographic time interval from P-wave to the beginning of the backward motion of the mitral valve.<sup>10</sup> P-wave dispersion (PWD) is associated with fragmentation of the depolarizing wave front in the atrium with nonuniform refractoriness.<sup>13</sup> Although the relation between PWD and post operative AF has been investigated, there is limited data about the relation between PWD and post-CABG AF. Therefore, our observational study aimed to investigate the role of PWD in preoperative risk stratification among patients after elective isolated CABG.

### Materials and Methods

Among patients with coronary artery disease who underwent primary isolated elective CABG, 52 patients with no baseline intraatrial conduction delay or clinical history of atrial dysrhythmia one week before surgery were selected randomly. Patients with uninterpretable echocardiogram (ECG) for P wave assessment, patients with implanted preoperative atrial or ventricular pacemaker, and those who required antiarrhythmic therapy other than  $\beta$ -blockers were excluded from the study. All medications as well as  $\beta$ -blockers were continued until cardiac surgery. Patients

older than 70 years of age were excluded from the study to remove the age bias on AF development in patient groups. Before the operation, the presence of risk factors like diabetes mellitus, hypertension, and smoking were asked from the patients. Ejection fraction, regional wall motion abnormality and mitral regurgitation were determined by transthoracic ECG. Angiographic data provided information about stenosed vessels. A 12-lead ECG at a signal size of 10 mm/mV and paper speeds of 25 mm/s and 50 mm/s was recorded in all patients at preoperative time and either day 1 or 2 after surgery. The same standard was employed for all recorded ECGs. On surface ECG, P-wave duration was measured from the beginning (junction between the isoelectric line and the beginning of P-wave deflection) and the end of the P-wave (junction between the end of P-wave deflection and isoelectric line). PWD was measured by calculating the difference between the duration of the longest and the shortest P-waves in lead II in milliseconds (ms) by one investigator. The incidence of post-CABG AF was detected by ECG and rhythm monitoring during the hospitalization period until discharge. The primary end point, AF, was defined as fibrillation rhythm lasting more than 10 minutes or the need for urgent intervention due to unstable hemodynamic status. Differences between pre- and postoperative variables were analyzed by Fisher's exact test. P values less than 0.05 were considered as statistically significant. Mann-Whitney test was used for comparison between parameters before and after CABG. Linear regression analysis was used for associations between parameters before and after CABG. All statistical analyses were performed in SPSS (SPSS Inc., Chicago, IL, US).

### Results

The overall incidence of post-CABG AF was 15.38%. The relationship between AF and patient parameters are presented in table 1. The longest P wave was seen in inferior leads and V4-6 and the shortest P wave was seen in I and aVL. The mean PWD values in AF and non-AF groups before CABG were 47.5 and 23.7 ms, respectively. Post-surgical mean PWD in AF group vs.

**Table 1.** Comparison of patient parameters in atrial fibrillation (AF) and non-AF groups

Parameter	AF	Non-AF	P
Age (years)	57.82	57.72	> 0.050
Female gender	47.50%	20.50%	>0.050
Male gender	62.50%	79.50%	0.366
Hypertension	75%	36.40%	0.058
Diabetes mellitus	62.50%	22.70%	0.036
Smoking	37.50%	36.40%	1.000
Ejection fraction	37.50-40%	49.90%	0.003
Regional wall motion abnormality	87.50%	52.30%	0.118
Mitral regurgitation	50%	22.70 %	0.189

non-AF group was 48.10 vs. 24.4 ms. The prevalence of significant stenosis in left circumflex (LCX) in post-CABG AF and non-AF groups was 100% vs. 88.6% ( $P = 1.000$ ). Significant stenosis in right coronary artery (RCA) was detected in 100% and 77.3% of post-CABG AF and non-AF groups, respectively ( $P = 0.328$ ). The corresponding values for significant stenosis in left anterior descending (LAD) were 87.5% and 93.18% ( $P > 0.05$ ). Before CABG, the mean ejection fraction value and minimum P-wave duration in AF group were lower than non-AF group ( $P = 0.005$  and  $< 0.001$ , respectively). Maximum P-wave duration and age showed no significant difference between AF and non-AF groups before CABG ( $P = 0.204$  and  $0.558$ , respectively). A reverse relation was present between minimum P wave duration and PWD ( $r = 0.77$ ;  $P < 0.001$ ). The likelihood ratio of post-CABG AF in diabetic patients was 5.6 (95% CI = 1.1-27.9). The association between other risk factors and post-surgical AF was non-significant ( $P > 0.05$ ). There was a negative association between high ejection fraction values and decreased PWD ( $r = -0.413$ ;  $P = 0.002$ ). There was no association between the stenosed vessel and P-wave duration and dispersion ( $P > 0.05$ ).

### Discussion

Previous data has demonstrated the prophylactic benefits of digoxin,  $\beta$ -blockers, magnesium or a combination of these drugs for post-CABG AF.<sup>14</sup> However, medical prophylaxis against post-CABG AF is limited by other medical diseases like asthma and thyroid or liver disorders.<sup>15,16</sup> We found 15.38% of patients to develop post-CABG AF which was within the reported range for the prevalence of the condition (11-40%). The increased use of percutaneous coronary intervention for reperfusion shifted the routine CABG operation for many older patients. Previous reports estimated a 24% increase in the incidence of new onset postoperative AF with each additional 5 years of age.<sup>17</sup> Age-related degenerative change and electrophysiological abnormality of atrial cells are main causes of post-CABG AF in advanced age, mainly older than 70 years of age.<sup>7,18</sup> We failed to demonstrate the effect of age because the mean age of included patients was lower than 60 years. In addition, similar to our findings, several previous studies could not find significant associations between post-CABG AF and age, gender, diabetes, and hypertension.<sup>10</sup> In the present study, the incidence of new onset post-CABG AF in patients with low ejection fraction was similar to the previous reports. Although the presence of mitral regurgitation was believed to be a risk factor for relation in our study,<sup>19</sup> development of post-CABG AF, we failed to find this.

A notable finding of the present study was that

PWD and mean P wave duration were the main independent predictors for the development of postoperative AF. This is similar to the reported higher risk of post operative AF in patients with abnormal P wave morphology.<sup>19</sup> Increased P-wave duration on signal-averaged ECG is believed to be able to identify patients at risk of post operative AF but it is not powerful enough to predict post CABG AF.<sup>13</sup> Postoperative changes in P-wave characteristics may be due to fluid overload and atrial stretch.<sup>20</sup> P-wave duration and dispersion can be decreased by fluid diuresis.<sup>13</sup> Preoperative electrocardiographic P-wave duration and PR interval have been suggested as potential predictors of AF with moderate sensitivity and no significant difference between AF and non-AF groups.<sup>13</sup> Some studies have shown that P-wave duration and dispersion were significantly shorter in patients with postoperative AF due to the increased B-adrenergic tone.<sup>13</sup> Despite these controversies, very limited studies have revealed an association between increased PWD and post-CABG AF. PWD indirectly reflects interatrial conduction defect and abnormalities of atrial size and structure.<sup>13</sup> It is a marker of atrial depolarization heterogeneity.<sup>13</sup> PWD reflects slow conduction in either atrium with subsequent retrograde activation and intra- and interatrial asynchrony.<sup>21</sup> Greater PWD in patients with paroxysmal AF indicates dispersion of atrial refractoriness and favors a re-entry mechanism. It is thus essential for the development of sustained arrhythmia.<sup>13</sup> Overall, the effect of increased PWD in the incidence of post-CABG AF has been reported to be moderate. P-wave dispersion  $> 25$  ms in patients with anterior myocardial infarction has been found to be independently associated with AF.<sup>13</sup> In this study, post-CABG AF was associated with pre- and postoperative PWD of 47.5 and 48.10 ms, respectively. Balloon occlusion of the right coronary artery in patients undergoing percutaneous angioplasty has been suggested as associated with increased P-wave duration and dispersion.<sup>20</sup> We found no relations between the stenosed vessel and P-wave duration and dispersion. However, a negative association was detected between ejection fraction values and PWD.

Despite the benefits of  $\beta$ -blockers and class III agents, such as amiodarone, in preventing post-CABG AF, the incidence of post-CABG AF remained high. In this study lower preoperative EF and increased postoperative PWD were independently associated with post CABG AF. P-wave duration and PWD, the main electrophysiological causes of AF, are noninvasive markers of the development of post-CABG AF. In addition to clinical conditions, these parameters can be used for selective prophylaxis in high risk patients to avoid costly and non-judicial use of prophylaxis for all patients undergoing CABG.

Because most episodes of postoperative AF occur by postoperative days 2 or 3, evaluating PWD in the early postoperative period may be clinically more useful in predicting AF occurrence. In patients with great PWD before the incidence of AF, biatrial pacing during CABG operation can be activated as anti-arrhythmia pacing.<sup>21</sup> Preoperative magnesium treatment can also be used in these patients to reduce PWD and occurrence of AF.

### Conclusion

AF often occurs after CABG and results in increased hospital stay. To identify patients at risk for AF after isolated CABG, minimum P wave duration, PWD, and low ejection fraction are good predictors and can be used for patient risk stratification.

### Conflict of Interests

Authors have no conflict of interests.

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