Effect of CABG on P-wave Dispersion and the Relationship between AF and P-wave Dispersion

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Background: Atrial fibrillation (AF) is a common complication after CABG. It is associated with doubling of mortality rate and increased incidence of CHF, MI, renal insufficiency, and stroke which prolongs hospital stay and is associated with increased rate of re-hospitalization.
In this study we examined the effect of CABG on atrial electrophysiology as reflected by P-wave dispersion.
Patients and Methods: A total of 197 consecutive patients undergoing elective CABG due to CAD were monitored for 4 days in hospital and their daily ECGs were obtained. .Differences in P-wave dispersions were compared between the patients who developed AF and those maintaining sinus rhythms.
Results: Post-operative AF occurred in 18.2% of patients, who showed statistically significant increase of P wave duration, in lead aVL of pre-op ECG (79.4±25.0 vs 70.1±22.4; P = 0.032). In addition, P wave dispersion was significantly increased on first and third days of post-op period (77.2±22.0 vs 67.5±22.2; P=0.018) and (69.4±22.7 vs 61.1±20.3; P= 0.035) respectively, in those developing AF rhythm compared to patients remaining in sinus rhythm .
Conclusion: Our result indicates that P-wave dispersion is a risk factor for development of AF in patients undergoing CABG.

Key words: P-wave Dispersion, AF, CABG

Introduction

AF is a common complication after CABG.[1] Post-op AF is associated with increased risk of stroke, CHF, MI, and renal insufficiency which in turn increases short and long term mortality[2] and prolongs hospital stay. The mechanism of this arrhythmia is believed to be reentry.[3] It is also one of the most frequent complications after cardiothoracic surgery (10-40%).[4] Most episodes of AF occur within the first few post-operative days with peak incidence on the second and third days.[5] The exact electrophysiologic mechanism of AF after cardiac surgery is not yet well understood.[6] Patients developing post-CABG AF usually show no previous history of AF episodes.[1,4]

P-wave dispersion constitutes a recent contribution to the field of non-invasive electrophysiology and is defined as the difference between the longest and the shortest P-wave durations recorded from multiple different surface ECG leads.[7] P-wave dispersion has proved to be a sensitive and specific ECG predictor of AF in the various clinical settings.[8]

Thus the aim of this study is to measure P-wave dispersion and to determine the potential predictive value of P-wave changes, relative

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to clinical factors, in the incidence of post-operative AF in patients undergoing CABG.

Patients and Methods

The present study was conducted between April 2008 and March 2009 and comprised all consecutive CABG patients, meeting the pre-specified criteria,and operated by a single expert cardiac surgeon. A written informed consent was obtained from all patients upon enrollment in the study. Inclusion criteria consisted of all consecutive patients undergoing elective CABG without concomitant cardiac or non-cardiac surgical procedures in Ordibehesht hospital, Shiraz, Iran. Exclusion criteria were patients with current AF or recently terminated AF (within 1week), uninterpretable ECG for the assessment of the P-wave, or patients with single or dual chamber pacemakers.

All patients had continuous post CABG cardiac monitoring (telemetry) during the study period. Daily ECGs were taken before operation and for 4 days after CABG. All P-wave measurements were performed in 12 leads ECG.

The beginning of the P-wave was defined as the junction between the isoelecteric line and the beginning of the P-wave deflection and the terminal part of the P-wave was characterized as the junction between the end of P-wave deflection and the isoelecteric line.[1] P-wave duration was measured from the onset to the offset of the P-wave.[1] P-wave dispersion a measurement of the heterogenicity of atrial depolarization was measured as the differences between the duration of the longest and the shortest P-wave in all leads. All final values were derived from the average of two measurements recorded for each variable. In addition to P-wave characteristic measurements, all 12 leads ECG were examined for other abnormalities such as MI (ST elevation). All patients were followed daily with heart monitoring and daily ECG for 4 days. AF was defined as AF lasting for a minimum of 30 minutes[1]. ECG evidence for pericarditis was determined by ST elevation of 1mm or more in all leads except aV_R and V_1 and P-R depression in all leads except V_1 and aV_R. Changes between pre and post-operative P-wave variables between AF and normal sinus rhythm were evaluated using student's t-test.

The association between AF and categorical predictors such as sex, history of MI, DM etc ,was assessed by Chi-square test and comparison between means of metric variables made by t-test. Also we used multiple linear logistic regression to determine the adjusted risk of predictors. The demographic data such as age, sex were evaluated in two groups; group with AF and that of normal sinus rhythm. Other factors evaluated in this study included presence of DM , HTN, history of MI, CHF, use of medications such as beta blockers, calcium channel blockers, nitrates and serum electrolytes (Na, K, Ca). Surgical factors such as aortic cross clamp time, by pass time, number of grafts and use of intraoperative defibrillator and post-op conditions such as reoperation for any reasons were also taken into account. Those predictors that have significant association with post-operative AF on univariaty analysis were entered in a multiple logistic regression model. All ECG's in patients with AF and in normal sinus rhythm were evaluated for P-wave dispersion as a whole, in pre-op

Table 1. Clinical characteristics of patients undergoing CABG

Clinical characteristics	No AF (n=161)	AF (n=36)	P value
Age (yr)	60.3 ± 11.9	63.2 ± 10.1	0.187
Sex (M/F)	103/53	20.16	0.238
Diabetes Mellitus	55.6%	44.4%	0.46
HTN	16.7%	83.3%	0.031
Hx of MI	40%	60%	0.22
Hx of CHF	18.5%	17.2%	0.87
pre op nitrate use	52.8%	47.2%	0.25
pre op bet a blocker use	76.5%	80.6%	0.60
pre op ca. chan. blocker use	21%	36.1%	0.059
BSA (M²)	1.79 ± 0.17	1.78 ± 0.18	0.79
Cross clamp time (Min)	30.1 ± 9.1	32.0 ± 8.8	0.28
Cardio.pul.bypass time (Min)	50.3 ± 13.8	47.24 ± 9.5	0.22
Number of grafts	4.1 ± 1.1	3.8 ± 0.7	0.24
Use of Intraop. Defibrillator	0%	2.8%	0.057
Return to operating room	2.6%	2.8%	0.95

and post-op, as well as comparing ECG leads in two groups.

Results

As shown in Table 1, among 197 consecutive CABG patients under study, AF occurred in 36 patients of post CABG (18.2%).

All these patients were pretreated with beta blockers and/or calcium channel blockers. In univariaty analysis factors independently predicting AF after CABG were hypertension and P-wave dispersions. But multiple logistic regression showed that hypertension was not statistically significant at α =0.05 but this difference was significant at α =0.1 which showed 2.7-fold increase in the risk of hypertension compared to patients without AF. As for P-wave dispersion (Table 2), multiple logistic

regression showed only P-wave dispersion on the first day of post-op which correlated with the development of AF (P:0.042; OR:1.02).

This indicated that in each millisecond (ms) rise in P-wave dispersion the risk of AF is increased by 1.02 fold. On the other hand if P-wave dispersion is increased for 10^{ms} the risk of AF is 20% or 1.02^{10} =1.2(Table 2).

In regard to gender, there was no significant difference among patients who developed AF (female: 44.4%, male: 55.6%; P= 0.238).

Patients with AF were older than those who remained in sinus rhythm. However, there was no significant difference between the two groups. As shown in Table 1, mean age in patients with AF was 63.2 ±10.1 and that of cases without AF was 60.3 ±11.9 (P= 0.187).

Also as demonstrated in Table1, the pa tients

Table 2. Logistic regression analysis

Variable	Coefficient	P value	OR
HTN	0.994	0.059	2.703
$aV_L ECG_0$	0.012	0.152	1.012
P-wave dispersion ECG_1	0.019	0.042	1.019
P-wave dispersion ECG_3	0.010	0.344	1.010
cons	-5.170	0.000	0.006

EKG_0: Pre-OP ECG; ECG_1 1 Study Post-OP EKG_3; ECG_3 : 3 rd day Post-OP ECG

who developed AF had similar body surface area compared to those with sinus rhythm (mean=1.78±0.18 vs 1.79±0.17; P= 0.79).

Likewise surgical factors such as cross clamp time (mean=32.0±8.8 vs 30.1 ±9.1, P=0.280); cardiopulmonary bypass time (mean=47.2±9.5 vs 50.3±13.8; P=0.22) were similar in two groups (Table 1). There were minor baseline differences between EF in the two groups which were not statistically significant (mean= 48.9±11.8 vs 51.1±11.5; P= 0.35).

As demonstrated in Table1, significant differences in the history of hypertension were found between individuals with and those without AF (83.3 vs 16.7, P= 0.031). In addition the prevalence of DM in two groups was similar (44.4 vs 55.6; P=0.460).

All patients were receiving either beta blockers and /or calcium blockers at the time of their operations. For this reason, preoperative drug treatments including beta blockers (80.6% vs 76.5%; P=0.600), calcium channel blockers were similar in both groups (36.1% vs 21%,

P=0.059). Also serum electrolytes (Na, K, Ca) were similar in patients with AF and those with normal sinus rhythm (P value>0.05)

There was no ECG evidence of pericarditis in any post op ECGs. Multiple logistic analysis demonstrated that hypertension was independent predictor of post-op AF at 0.1 significant level (P=0.059).

ECGs of patients with and without AF (Table 3) in pre and post-CABG showed that P-wave dispersion increased by 10^{ms} on the first post-op day in those with AF compared to pre-op values (P=0.018). Likewise, P-wave dispersion increased by 8ms on the 3rd post-op day in patients who developed AF (P= 0.035).

No significant association was detected (Table 3) between P-wave dispersion and AF on other days.

Interestingly, P wave duration in lead aVL was significantly prolonged in preoperative ECGs in patients who ultimately developed AF compared to those remaining in sinus rhythm (79.44±25.0 vs 70.12±22.4; P=0.032).

Table 3. P-Wave dispersion in patients who developed AF and those with normal sinus rhythm. Pre-op P wave durations in aVL are shown in the third row

Variable	With AF		Without AF		P value
	no	Mean (SD)	no	Mean (SD)	
ECG_1	36	77.2 (22.0)	156	67.5 (22.2)	0.018
ECG_3	36	69.4 (22.7)	161	61.1 (20.3)	0.035
$ECG_{0\,aVL}$ lead	36	79.4 (25.0)	161	70.1 (22.4)	0.032

ECG: Pre-OP ECG_3: 3rd day Post OP ECG

Discussion

Incidence of AF varies between 5-40% during the first post operative week.[1] This variation in the incidence of AF is dependent on the patient population studied, type of cardiac surgery, definition of the arrhythmia, the method used for detecting arrhythmia, and the duration of the observation period.[1]

The logic underlying P-wave dispersion is that site-dependent heterogeneity atrial conduction may result in a highly variable P-wave duration recorded from surface leads. Previous study by Joby chandy et.al showed that P-wave dispersion was a risk factor for post-CABG AF[1]. Another study by Vassilios Vassilikos and colleagues showed that P-wave analysis is a very sensitive method of identifying patients who are likely to develop AF after CABG[7]. But none of the studies evaluated P-wave dispersion in all ECG leads. In previous investigations age was identified as an independent risk factor for developing AF.[9] However, in this study although AF occurred more often in older individuals, compared to younger age group,   the difference was not statistically significant. Likewise, there was no significant difference in the sex, BSA, DM, history of MI, or CHF between patients who developed AF and those who remained in normal sinus rhythm despite previous report that considered BSA as a risk factor.[1]

We could not detect any significant difference in the incidence of AF when considered different surgical variables, such as aortic cross clamp time, number of vein grafts used, and cardiopulmonary bypass time which was consistent with previous studies.[10] Likewise, there was no correlation between different types of medications including beta blockers, calcium channel blockers, and nitrates used prior to CABG, and the incidence of post-operative AF which was also similar to the findings of previous studies.[11]

Conclusion: Measuring P-wave dispersion on the first day of post-CABG is valuable mehtod   for predicting AF in those who are pretreated with beta blockers and/or calcium channel blockers.

Our study only focused on the early postoperative period. This may have underestimated the incidence of postoperative AF which might occur in the late postoperative period.

References

1 Chandy J, Nakai T, Lee R, et al. Increases in P-wave dispersion predict postoperative atrial fibrillation after coronary artery bypass graft surgery. *Anesth Analg* 2004;**98**:303-10. [14742359]

2 Hosokawa K, Nakajima Y, umenai T, et al. Predictors of atrial fibrillation after off pump coronary artery bypass graft surgery. *Br J Anaesth* 2007;**98**:575-80. [17403706]

3 Hogue CW Jr, Creswell LL, Gutterman DD, et al. Epidemiology, mechanisms, and risks: American College of Chest Physicians guidelines for the prevention and management of postoperative atrial fibrillation after cardiac surgery. *Chest* 2005;**128**:9s-16s. [16167659]

4 Poli S, Barbaro V,Bartolini P, et al. Prediction of atrial fibrillation from surface ECG: review of methods and algorithms. *Ann Ist Super Sanita* 2003;**39**:195-203. [14587218]

5 Dilaveris PE, Gialafos JE. P-wave dispersion:A novel predictor of paroxysmal atrial fibrillation. *Ann Noninvasive Electrocardiol* 2001;**6**:159-165. [11333174]

6 Khasnis A, Thakur RK. Atrial fibrillation: a historical perspective. *Cardiol Clin* 2009;**27**:1-12. [19111759]

7 Vassilikos V, Dakos G, Chouvarda I, et al. Can P wave wavelet analysis predict a trial fibrillation after coronary artery bypass grafting? *Pacing Clin Electrophysiol* 2003;**26**:305-9. [12687834]

8 Cagle K, Ergun k, Lafci g, et al. QT and P-wave dispersion. *Journal of Ankara University Faculty of Medicine* 2005;**58**:42-46.

9 Mathew JP, Fontes ML, Tudor LC, et al. A multicenter risk index for atrial fibrillation after cardiac surgery. *JAMA* 2004;**291**:1720-9. [15082699]

10 Buxon AE, Josephson ME. The role of P-wave duration as a predictor of postoperative atrial arrhythmias. *Chest* 198;**80**:68-73. [6972856]

11 Kaireviciute D, Aidietis A, Lip GY. Atrial fibrillation following cardiac Surgery: Clinical features and Preventive strategies. *Eur Heart J* 2009;**30**:410-25. [19174427]