

Original Article

Right atrial dyssynchrony and atrial fibrillation after coronary bypass grafting surgery

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Abstract

Introduction: Prevalence of post-coronary bypass grafting surgery (post-CABG) atrial fibrillation (AF) is high, and its complications are serious. Prediction of this problem and prophylactic or presumably curative managements may be helpful not only in post-CABG AF, but also in other conditions that predispose patients to AF. The aim of this study was finding relationship between right atrial (RA) dyssynchrony and post-CABG AF occurrence.

Methods: One hundred patients who were candidates for CABG and they had sinus rhythm was evaluated. We measured RA dyssynchrony in tissue Doppler imaging (TDI) using initiation of P wave in the electrocardiogram to peak A wave (on TDI) in mid of RA free wall and mid of inter-atrial septum (IAS). The time difference from the onset of the P wave to the onset of the A wave at the right atrium (P-RA) and the IAS (P-IAS) was measured. RA dyssynchrony was defined as the difference between P-IAS and the P-RA. Patients were followed for occurrence of AF 72 h after CABG through Holter monitoring, the relation between AF occurrence and RA dyssynchrony was determined.

Results: AF developed in 24 patients (24%), based on statistical analysis, lower LVEF and RA dyssynchrony had relationship with AF occurrence. RA dyssynchrony was significantly increased in patients with postoperative AF (36.67 ± 14.93 ms vs. 14.27 ± 13.77 ms, $P < 0.001$).

Conclusion: We demonstrated that RA dyssynchrony based on TDI could be a predictor for the occurrence of post-CABG AF.

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Introduction

Atrial fibrillation (AF) is one of the most frequent complications of coronary artery bypass grafting (CABG).¹ It occurs up to 40% of patients, primarily within 2-3 days. In the early postoperative period, rapid ventricular rates and loss of atrial transport may compromise systemic hemodynamics, increase the risk of embolization, and lead to a significant increase in the duration and cost of the hospital stay; it is associated with a two-fold to threefold increase in postoperative stroke.² Older age, hypertension, prior AF, and heart failure are

associated with higher risk of developing AF after cardiac surgery.³ Although these risk factors have been associated with postoperative AF but all determinants of this problem have not fully understood.

Evaluation of atrial dyssynchrony in previous studies was useful in predicting of AF in patients with heart failure⁴ and sinus node dysfunction,⁵ but it was not evaluated in patients who are candidates for coronary bypass surgery.

The aim of this study was to investigate the correlation between right atrial (RA)

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dyssynchrony assessed preoperatively using tissue Doppler imaging (TDI) analysis and the occurrence of AF in patients undergoing CABG.

Methods

The study population consisted of the patients who were candidates for first CABG and they were in sinus rhythm, we excluded patients with a preoperative history of AF or atrial flutter, significant valvular heart disease (more than moderate valvular dysfunction), left ventricular ejection fraction (LVEF) less than 35%, need for class 1 or 3 antiarrhythmic drugs for at least 1 week before surgery, prior coronary revascularization, emergency surgery, New York Heart Association Functional Class of 3 or 4, thyroid disease, active inflammatory disease or sepsis, left atrial size > 50 mm, RA size > 40 mm, electrolyte imbalance, chronic renal failure requiring dialysis, poor echocardiographic image quality and recent myocardial infarction (< 1 month). We finally studied 100 patients.

All patients underwent a preoperative transthoracic echocardiography with TDI analysis. After CABG, the patients were monitored with Holter monitoring for 72 h. Standard transthoracic echocardiography was performed in the left lateral position with 2.5-3.5 MHz transducer. The LVEF was calculated by the modified Simpson method from apical four- and two-chamber views. Pulsed-wave Doppler recordings of trans-mitral inflow were obtained in the apical four-chamber view with the sample volume placed at the orifice of the mitral valve for assessing diastolic function.

Color coded TDI of the atria in the apical four-chamber view was done. Gain setting, filters, and pulse repetition frequency were adjusted to optimize color saturation for the highest possible frame rate. The tissue Doppler signals were recorded at a sweep speed of 100 mm/s. Echocardiographic data were stored digitally to allow off-line analysis. From the digitally stored color tissue Doppler images, time-velocity curves

were measured on the middle of the RA free wall and the inter-atrial septum (IAS). The A wave on the color tissue Doppler curve was defined as the second negative deflection at diastole. The smallest temporal resolution was 10 ms. The time difference from the onset of the P wave to the onset of the A wave at the right atrium (P-RA) and the IAS (P-IAS) was measured and was defined as the RA dyssynchrony.

Statistical analysis was performed using SPSS for Windows (version 21, SPSS Inc., Chicago, IL, USA). Comparisons between groups were performed with Mann-Whitney U analysis for quantitative variables and chi-square or Fisher's exact test for qualitative variables. Statistical significance was established at $P < 0.05$.

Results

Hospital mortality was 1 of 100 (1.0%). During 72 h after the surgery, AF was recorded in 24 of 100 patients (24.0%), and none of them experienced thromboembolic complications. AF occurrence was more prevalent in the second day after surgery, followed by 3rd and 1st day respectively. Range of patient's age was 31-78 years (mean age: 58 years). Although the mean age of patients in AF group was higher than patients without AF (62.20 ± 8.40 vs. 57.70 ± 8.98 respectively), but the difference was not significant ($P = 0.145$). There were also no significant differences between AF and the non-AF group in sex and body surface area. Prevalence of coronary artery disease (CAD) risk factors including hypertension and diabetes were relatively similar between two groups, small subset of patients had left main artery involvement (12.5% of AF group and 6.6% of non-AF group), which was not meaningful ($P = 0.200$), all patients had left anterior descending artery involvement, left circumflex artery had significant stenosis in 22 patients (91.0%) of AF group and 64 patients (84.2%) of non-AF group ($P = 0.200$). Right coronary artery involvement also was not different between two groups (83.3% vs. 85.5% in AF and non-AF group respectively, $P = 0.500$). Statin

and beta-blocker consumption were high in both groups without significant differences (Table 1).

Table 1. Demographic findings

Variables	AF (n = 24)	Non-AF (n = 75)	P
Age (year)	62.20 ± 8.40	57.70 ± 8.98	0.145
Male/female	3.80	4.00	0.961
BSA	1.85 ± 0.18	1.84 ± 0.18	0.547
Hypertension (%)	15 (62.5)	41 (54.7)	0.315
DM (%)	8 (33.0)	29 (38.7)	0.417
LM (%)	3 (12.5)	5 (6.0)	0.292
3VD (%)	18 (75.0)	51 (68.0)	0.614
Statin (%)	24 (100)	73 (97.3)	0.435
Beta-blocker (%)	24 (100)	68 (90.0)	0.100

AF: Atrial fibrillation; BSA: Body surface area;
DM: Diabetes mellitus; LM: Left main;
3VD: Three vessel disease

Echocardiographic findings

LVEF was lower in AF group (47.60 ± 5.90 vs. 51.00 ± 7.29) and the difference was significant (P = 0.009). Majority of patients had grade 1 diastolic dysfunction (91.0% of AF group and 87.0% of the non-AF group) which means there is no significance difference in diastolic function between two groups, left atrium (LA) size was relatively similar between two groups (37.90 ± 6.10 mm vs. 39.10 ± 9.90 mm in AF and the non-AF group respectively). RA dyssynchrony was more obvious in AF group. Mean dyssynchrony times in AF and the non-AF group were 36.67 ms versus 14.27 ms, respectively (P < 0.001) (Table 2).

Table 2. Echocardiographic findings

Variables	AF (n = 24)	Non-AF (n = 75)	P
LVEF (%)	47.60 ± 5.90	51.00 ± 7.29	0.009
DDG1 (%)	22 (91.0)	65 (87.0)	0.067
LA size (mm)	37.90 ± 6.10	39.10 ± 9.90	0.371
RA dyssynchrony (ms)	36.67 ± 14.93	14.27 ± 13.77	< 0.001

LVEF: Left ventricular ejection fraction; RA: Right atrium
DDG1: Diastolic dysfunction grade 1; LA: Left atrium;

Discussion

This study has shown that RA dyssynchrony based on TDI echocardiography may be helpful in predicting of post-CABG AF.

Several risk factors for AF after open heart surgery have been identified, including age

older than 70 years, history of prior AF, male gender, left ventricular dysfunction, left atrial enlargement, chronic lung disease, diabetes, and obesity.⁶

Independent predictors of AF include age older than 75 years, history of AF, diabetes, duration of CPB and cross-clamp time, bicaval cannulation, inadequate protection of the atria during cross-clamping, postoperative serum elevation of both epinephrine and norepinephrine, and postoperative high doses of non-steroidal anti-inflammatory drugs.⁷ In this study, some of those risk factors had been omitted such as history of AF, some of them had not affected AF occurrence such as diabetes and older age presumably due to low population of the study and some of them did not evaluate such as a plasma level of epinephrine and norepinephrine.

Although the prevalence of post-CABG AF is estimated to be as high as 40%, the relatively low incidence in our study (24%) is due to exclusion of some variables that were known as the important risk factors of AF occurrences such as severe systolic dysfunction, significant valvular heart disease and significant LA enlargement. In our study, incidence of AF is relatively equal between males and females (23.8% and 25.0% respectively), but it seems it is due to low number of study population, it is also true about CAD risk factors and involved coronary arteries.

Prior statin therapy⁸ and beta-blocker use² were known to be protective against postoperative AF, in our study these drugs had been more used in patients with AF, this is because AF group had some risk factors such as lower ejection fraction, which reduces the protective effect of these drugs. Nevertheless, exclusion of patients with severe systolic dysfunction (LVEF lower than 35%), AF group had lower LVEF in comparison with the non-AF group (47.60-5.90 vs. 51.00-7.29, P = 0.009). There was no significant difference in LA size between two groups, because patients with significant LA enlargement had been excluded from the study to eliminate

consequences of structural abnormalities on atrial dyssynchrony.

Several attempts have been utilized to predict post-CABG AF, some of them were echocardiographic technics and among them atrial evaluation with TDI was more successful, for example it has been shown that low peak atrial systolic mitral annular tissue Doppler velocity could predict postoperative AF.⁹

Atrial dyssynchrony was shown to be helpful in predicting future development of chronic AF in patients with non-valvular paroxysmal AF¹⁰ but it has not been shown in patients who have undergone CABG.

Atrial conduction delay is one of the important features of AF. Atrial electromechanical abnormalities caused by atrial conduction abnormalities have been reported as a risk factor for AF.¹¹ Previous studies has shown a relationship between left atrial volume and postoperative AF,¹² but it seems right atrium had been less evaluated as a marker for developing AF. In this study, we used TDI to evaluate RA dyssynchrony. Our patients with post-CABG AF, had prolonged RA dyssynchrony compared with those without AF. Thus, we demonstrated that RA dyssynchrony is useful for predicting

post-CABG AF.

Limitations

Our study has several limitations, first the study population was low, second some episodes of AF may have been missed due to limited time of electrocardiographic monitoring, third the complications was followed only during hospitalization and finally atrium myocardial sampling in color coded TDI may be interrupted with blood velocity so more studies is needed to confirm our findings.

Conclusion

We demonstrated that RA dyssynchrony based on TDI could be used as the predictor of post-CABG AF.

Conflict of Interests

Authors have no conflict of interest.

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