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Research Paper

Predictors of post coronary artery bypass grafting atrial fibrillation☆

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Abstract

Objective: To investigate the incidence and relative risk factors of post coronary artery bypass grafting (post-CABG) atrial fibrillation (AF). **Methods:** 312 patients with CABG were reviewed and divided into an AF group and a non-AF group. Statistical analysis was used to compare the data between the two groups and screen for risk factors of post-CABG AF. **Results:** 103/312 (33.01%) patients developed post-CABG AF. Univariate analysis showed that patients in AF group compared with those in non-AF group were more likely to have advanced age (≥70 years), early postoperative withdrawal of β-blockers, hypertension, left atrial enlargement (≥40 mm), a history of AF, prolonged p-wave duration (≥120 ms) and increased number of grafts (≥3). Multivariate logistic regression analysis showed that advanced age (≥70 years), early postoperative withdrawal of β-blockers, hypertension, left atrial enlargement (≥40 mm) and a history of AF were highly related to post-CABG AF. **Conclusion:** The incidence of AF in patients following CABG was 33.01% in this study. Advanced age, early postoperative withdrawal of β-blockers, hypertension, left atrial enlargement and a history of AF were independent risk factors of post-CABG AF.

Keywords: coronary artery bypass grafting; atrial fibrillation; risk factors

INTRODUCTION

Atrial fibrillation (AF) is the most common arrhythmia after coronary artery bypass grafting (CABG), with an incidence ranging from 25% to 40% [1,2]. Post-CABG AF is self-limiting in most cases. However, even when AF is uncomplicated, its treatment requires additional medical and nursing time and a prolonged hospital stay[3]. In a minority of cases, post-CABG AF can cause hemodynamic compromise and increase risk of postoperative stroke[4]. The purpose of this study was to investigate the incidence and relative risk factors of post-CABG AF.

MATERIALS AND METHODS

Patients

From December 2002 to April 2006, 321 patients underwent isolated CABG in our hospital. 9 patients were excluded in this study (4 with permanent AF preoperatively, 1 with temporary pacing preoperatively and 4 dead postoperatively). The final number of subjects included in this study was 312 patients.

Diagnostic criteria

All patients received continuous ECG monitoring for at least 3 days post CABG. After cessation of ECG monitoring, an ECG was immediately performed when the patient had irregularity of pulse, palpitation, chest distress or other symptoms relating to possible AF. Post-CABG AF was diagnosed when AF episode duration was longer than 10 minutes during ECG monitoring and following ECG recording.

Data collection

312 eligible patients were reviewed and divided into an AF group (103) and a non-AF group (209) during hospital stay (within 1-3 weeks). Clinical data

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(including general clinical characteristics, results of coronary angiography, index of echocardiography and electrocardiogram,preoperative administration, intraoperative factors, postoperative administration and assisted ventilation time) possible related to post-CABG AF are presented in table 1~6.

Statistical analysis

Values are presented as mean±standard deviation or percent and examined using the Student's t test or χ^2 test. Multivariate logistic regression was used to determine the independent risk factors of post-CABG AF.

RESULTS

103/312 (33.01%) patients developed post-CABG AF. Most of them (77.9%) occurred on the 1st~3rd days post-CABG. Univariate analysis showed that patients in AF group compared with those in non-AF group were more likely to have advanced age(≥70 years) (55 /103 versus 53 /209, $P < 0.001$), early postoperative withdrawal of β-blockers(28/103 versus 18/209, $P < 0.001$), hypertension(82/103 versus 127/209, $P < 0.001$), left atrial enlargement (≥40 mm) (41/103 versus 47/ 209, $P = 0.002$), a history of AF (11/103 versus 2 /209, $P < 0.001$), prolonged p-wave duration(≥120 ms)(26/103 versus 31/209, $P = 0.024$) and increased number of grafts (≥3)(88/103 versus 158/209, $P = 0.045$), (***Tab 1-6***). Multivariate logistic regression analysis showed that advanced age(≥70 years)(OR = 3.376, 95% CI: 1.880-6.0633, $P < 0.001$), early postoperative withdrawal of β-blockers (OR = 6.721, 95% CI: 3.058-14.737, $P < 0.001$), hypertension (OR = 2.924, 95% CI: 1.523-5.615, $P = 0.001$), left atrial enlargement (≥40 mm) (OR = 2.378, 95% CI: 1.301-4.345, $P = 0.005$) and a history of AF (OR = 9.462, 95% CI: 1.539-57.732, $P = 0.015$) were independent risk factors of post-CABG AF,(***Tab 7***).

Tab 1 **General clinical characteristics between AF and non-AF group**

Group	Age(years)	≥70 years	Male	Hypertension	History of smoking
AF(103)	68.75 ± 5.76**	55(53.40%)**	85(82.52%)	82(79.61%)**	43(41.75%)
Non-AF(209)	63.32 ± 8.38	53(25.36%)	176(84.21%)	127(60.77%)	83(39.71%)

Group	Diabetes mellitus	History of AF	AMI	OMI
AF(103)	30(29.13%)	11(10.68%)**	15(14.56%)	18(17.48%)
Non-AF(209)	68(32.54%)	2(0.96%)	30(14.35%)	49(23.44%)

**$P < 0.01$; AMI = acute myocardial infarction;OMI = old myocardial infarction. Compared with non-AF group, patients in AF group were older and more likely to have advanced age(≥70 years),hypertension and a history of AF.

Tab 2 **Results of coronary angiography between AF and non-AF group**

Group	Number of diseased vessels	Triple diseased vessels	RCA disease	LMT disease
AF(103)	2.68 ± 0.58	75(72.82%)	91(88.35%)	27(26.21%)
Non-AF(209)	2.53 ± 0.79	142(68.27%)	168(80.77%)	52(24.88%)

RCA = right coronary artery; LMT = left main trunk. We didn't find significant difference between AF and non-AF group in coronary angiography.

Tab 3 **Index of echocardiography and electrocardiogram between AF and non-AF group**

Group	LVEF	LVEF < 0.4	LAD(mm)	LAD ≥ 40 mm	P wave duration (ms)	P wave duration ≥ 120 ms	PR interval (ms)
AF(103)	0.59 ± 0.10	3 (3.06%)	38.53 ± 4.64**	41 (41.00%)**	113.59 ± 12.30**	26 (25.74%)*	168.63 ± 23.70
Non-AF(209)	0.60 ± 0.10	11 (5.50%)	36.89 ± 4.39	47 (23.38%)	109.37 ± 12.26	31 (15.05%)	164.04 ± 24.05

*$P < 0.05$, **$P < 0.01$; LVEF = left ventricular ejection fraction; LAD = left atrial dimension. Compared with non-AF group, patients in AF group had lager left atrial dimension and longer P-wave duration; the cases of prolonged p-wave duration (≥120ms) and left atrial enlargement (≥40 mm) in AF group were more than those in non-AF group.

Tab 4 **Preoperative administration between AF and non-AF group**

Group	β-blockers	Digitalis	Calcium channel blockers	Amiodarone	ACEI/ARB
AF(103)	84(81.56%)	6(5.83%)	30(29.13%)	6(5.83%)	97(94.17%)
Non-AF(209)	178(85.17%)	11(5.26%)	48(22.97%)	17(8.13%)	182(87.08%)

ACEI = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker. We didn't find significant differences between AF and non-AF group about preoperative administration.

Tab 5 **Intraoperative factors between AF and non-AF group**

Group	CPB	CPBT/min	ACCT/min	Number of grafts	Number of grafts≥3
AF(103)	8(7.77%)	117.17 ± 56.45	68.33 ± 36.10	3.16 ± 0.68*	88(85.44%)*
Non-AF(209)	30(14.35%)	95.38 ± 25.82	50.33 ± 11.91	2.91 ± 0.86	158(75.60%)

*$P < 0.05$; CPB = cardiopulmonary bypass; CPBT = cardiopulmonary bypass time; ACCT = aorta cross-clamp time. Compared with non-AF group, patients in AF group had increased number of graft and more likely to have grafts number≥3.

Tab 6 **Postoperative administration and assisted ventilation time between AF and non-AF group**

Group	Assisted ventilation time/hours	Withdrawal of β-blockers	Digitalis	Calcium channel blockers	Amiodarone	Diuretic	ACEI/ARB
AF(103)	13.61 ± 5.68	28 (27.18%)**	32 (31.07%)	37 (35.92%)	24 (23.30%)	84 (81.55%)	45 (43.69%)
Non-AF(209)	13.82 ± 8.15	18 (8.61%)	67 (32.06%)	86 (41.15%)	36 (17.22%)	177 (84.69%)	103 (49.28%)

**$P < 0.01$; ACEI = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker. Compared with non-AF group, patients in AF group were more likely to withdraw β-blockers immediately after CABG.

Tab 7 **Multivariate logistic regression analysis**

Risk Factors	B	Wald	*P* Value	OR	95%CI
Age ⩾ 70 years	1.217	16.584	< 0.001	3.376	1.880~6.063
Withdrawal of β-blockers	1.904	22.523	< 0.001	6.712	3.058~14.734
Hypertension	1.073	10.387	0.001	2.924	1.523~5.615
LAD ⩾ 40 mm	0.866	7.929	0.005	2.378	1.301~4.345
History of AF	2.244	5.888	0.015	9.426	1.539~57.723

LAD = left atrial dimension; B = regression coefficient; OR = odds ratio; 95% CI = 95% confidence interval. Multivariate logistic regression analysis showed that age≥70 years, withdrawal of β-blockers, hypertension, LAD ⩾ 40 mm and history of AF were independent risk factors of CABG.

DISCUSSION

The incidence of post-CABG AF was 33.01% in our study. Its mechanism may be multifactorial. Currently, it is believed that prolonged atrial refractoriness, ischemia, inflammatory reaction and sympathetic activation are related to post-CABG AF[5,6]. In this study, we found out that advanced age, early postoperative withdrawal of β-blockers, hypertension, left atrial enlargement and history of AF were independent risk factors of post-CABG AF.

Advanced age and hypertension

Advanced age is the most often reported independent risk factor not only for AF among general population but also for post-CABG AF. In our study, the patients in AF group were older compared with those in non-AF group. Incidence of post-CABG AF increased progressively in patients aged ⩾70 years. Age-related structural changes, such as increased fibrosis, fat deposition and amyloidosis would result in intra-atrial conduction disturbances which may be responsible for intra-atrial re-entry and induction of AF [7,8]. Hypertension has also been proposed as a risk factor for AF both among general population and patients following CABG. Be similar to advanced age, patients with hypertension, demonstrated by endocardiac biopsy, exist atrial hypertrophy and fibrosis, which result in abnomality of atrial depolarization and conduction. Therefore it is easily to lead to intra-atrial re-entry and consequently occurrence of AF among patients with hypertension [9]. In addition, it is possible that unavoidable trauma to sympathovagal fibers originating from the deep or superficial cardiac plexus during surgery may be contributing to preexisting atrial electrical changes caused by aging or hypertension, predisposing to AF[10].

β-blocker

Withdrawal of β-blocker has been proposed as a possible cause of AF after cardiac surgery. When long-term β-blocker is abruptly discontinued, a phenomenon called β-blocking withdrawal effect follows. It is characterized by increased catecholamine concentration in plasma and increased sympathetic tone. Combined with surgery which further increases adrenergic activity, the β-blocking withdrawal facilitates occurrence of post-CABG AF [11,12]. In this study, most of the AF (77.9%) developed on the 1st~3rd days after CABG, during which β-blocker was abruptly discontinued and adrenergic activity was overly increased and early postoperatively withdrawal of β-blocker was found to be an independent risk factor of post-CABG AF.

Left atrial enlargement

Anatomical left atrial enlargement might cause increased dispersion of effective refractory period (ERP) and slow or anisotropic conduction in atrium which were predisposing factors for the development of AF. Atrial ischemia caused by surgery further aggravated the dispersion of ERP resulting in post-

CABG AF[13,14]. In this study, preoperative echocardiographic measurement of left atrium dimension was performed and left atrial enlargement (≥40 mm) was a risk factor for post-CABG AF.

History of AF

In several studies, preoperative history of AF is an independent predictor for post-CABG AF [15,16]. Patients with a history of AF appear to have an underlying pathologic substrate for the development of AF, and thus they are susceptible to post-CABG AF. Many studies have excluded patients with a history of AF because they are expected to be at greater risk for developing the post-CABG AF. In this study, these patients were included and history of AF was found to be an independent risk factor of post-CABG AF.

Other factors

Several studies have found that incidence of post-CABG AF was high in patients with left ventricular dysfunction [2,17]. But we found no significant difference for developing post-CABG AF between patients with and without left ventricular dysfunction in this study, perhaps the sample size was not large enough to reach statistical significance. The prophylactic therapy with amiodarone has been shown to be effective in decreasing the incidence of AF after CABG [18,19]. In this study, amiodarone were used to treat arrhythmias happening perioperatively but not to prevent post-CABG AF. Therefore,the analysis of prophylactic therapy with amiodarone was confounded and the result was not statistically significant.

In addition, it was found that ACEI or ARB could reduce the incidence of AF after acute myocardial infarction in patients with left ventricular dysfunction[20]. Because the objects investigated in our study were patients with CABG but not acute myocardial infarction, we did not find a relation between AF and perioperative administration of ACEI or ARB.

The incidence of AF in patients following CABG was 33.01% in this study. Advanced age, early postoperative withdrawal of β-blockers, hypertension, left atrial enlargement and a history of AF were independent predictors of post-CABG AF.

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