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Does Off-pump Coronary Artery Bypass Reduce the Prevalence of Atrial Fibrillation?

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ABSTRACT

Introduction: To examine whether or not off-pump CABG (Coronary Artery Bypass Reduce) reduces the incidence of AF after cardiac surgery.
Methods: The study was carried out in 939 consecutive coronary artery disease patients with sinus rhythm from which 383 patients underwent off-pump CABG, and 556 patients were operated through on-pump CABG. All patients were monitored postoperatively during intensive care unit (ICU) stay. Then, the incidence and predictive risk factors of post operative AF (POAF) in two groups were determined and compared with each other.
Results: Overall, the mean age of the patients was 56.0±12.8 years with 234 patients (24.9%) being older than 65 years. POAF developed in 38 patients (9.9%) of the off-pump and in 93 patients (16.7%) of the on-pump CABG. There was significant difference between two groups when considering the incidence of POAF (P=0.002). Among preoperative risk factors, age>65 years had a significant association with the incidence of AF in both groups. This study also showed that most of the POAF cases converted to sinus rhythm after treatment. Moreover, these finding demonstrated that conversion to sinus rhythm is significantly more probable in off-pump group (P=0.006).
Conclusion: A reduced prevalence of POAF could be observed in patients with off-pump as compared with on-pump techniques. Furthermore, conversion to sinus rhythm in off-pump group was significantly more probable than on-pump group.

Introduction

With an estimated prevalence of 5% to 29%, atrial fibrillation (AF) is the most common postoperative complication in patients undergoing off-pump coronary artery bypass grafting, with a peak incidence between second to third postoperative days.[1-3] Multifactorial mechanisms are blamed for postoperative AF in patients with the necessary atrial electrical substrate[4,5] while it could be of either slow atrial conduction nature or dispersion of atrial refractoriness.[6] It has been suggested that the incidence of postoperative AF may be increased as a consequence of surgical manipulation and, myocardial ischemia and inflammatory reactions related to perioperative cardiopulmonary bypass (CPB).[2] Interestingly, Off-pump CABG has been shown to be associated with a significant decrease in the inflammatory reactions[7] and myocardial necrosis markers release[8] compared with conventional CABG. If so, patients who undergo off-pump procedure should have a lower incidence of AF than patients undergoing standard CABG with CPB. Studies comparing off-pump CABG and CPB in younger patients group report contradictory evidence on the incidence of AF.[9,10]
The aim of this prospective study was to examine the influence of (off-pump versus on-pump) CABG approach and on POAF prevalence.

Materials and methods

This study was carried out on 939 consecutive coronary artery disease patients with sinus who were operated on at Shahid Madani heart center, Tabriz, Iran, in the period between April 2008 and May 2011. Patients with previous history of any surgery other than CABG, atrial fibrillation, atrial flutter, use of antiarrythmic drugs other than beta-blockers, and sustained ventricular tachyarrhythmia were excluded. A standard 12-lead ECG and trans-thoracic echocardiography laboratory tests were performed in all of the patients. For each patient a form including data related to preoperative, intraoperative and postoperative period was completed. The data were collected daily by trained and experienced research nurses.
In this study, 383 and 556 patients underwent off-pump

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and on-pump CABG, respectively. Clinical data are shown in Table 1. Off-pump CABG procedures were performed through a median sternotomy approach. Octopus was used to stabilize the target coronary vessel in all cases. Revascularization in on-pump CABG was performed by standard surgical technique with moderate systemic hyperthermia (30-32°c). Conduits for off-pump and on-pump CABG included the internal mammary artery or saphenous veins, or a combination of the two. All patients were continuously monitored postoperatively during the intensive care unit (ICU) stay. A 12-lead ECG recording was performed if necessary to confirm the AF episodes. In the present study, POAF was defined as the characteristic arrhythmia lasting for more than 5 minutes confirmed by a cardiologist. Beta-blockers were used routinely postoperatively and POAF was treated by amiodarone and replacement of potassium and magnesium. Some of the intra- and perioperative risk factors which potentially could influence the POAF incidence were collected and compared between groups. All continuous variables were presented as mean ± SD. Student t-test was used for analysis of continuous variables and Chi-squared test was used for

Table 1. The clinical profile of 939 patients with ischemic heart disease admitted for CABG

Characteristics	CABG with CPB (n=556)	OPCAB (n=383)	*P*-value
Preoperative risk factors			
Age(year, mean±SD)	54.8±13.9	58.9±10.6	0.000
Female patients	191 (34.4)	101 (26.4)	0.005
Smoking	202 (36.3)	168 (43.9)	0.012
History of MI	123 (22.1)	122 (31.9)	0.001
History of cardiac surgery	19 (3.4)	2 (0.5)	0.002
Diabetes	78 (14.0)	107 (27.9)	0.000
COPD	65 (11.7)	37 (9.7)	0.191
CVA	17 (3.1)	10 (2.6)	0.422
Peripheral vascular disease	7 (1.3)	1 (0.3)	0.097
Renal failure (cr≥2.5)	9 (1.6)	10 (2.6)	0.204
Beta-blocker consumption	407 (73.2)	313 (81.7)	0.001
Calcium channel blocker use	161 (29.0)	132 (34.5)	0.043
Diuretic consumption	85 (15.3)	43 (11.2)	0.045
Digoxin use	64 (11.5)	18 (4.7)	0.000
Amiodarone	9 (1.6)	1 (0.3)	0.041
Bronchodilator	19 (3.4)	10 (2.6)	0.308
Hypertension≥140/90 mmHg	43 (7.7)	48 (12.5)	0.000
Pulse≤70 beat/min	151 (27.2)	122 (31.9)	0.069
CCS>III	26 (4.7)	10 (2.6)	0.072
NYHA Function Class≥III	300 (54.0)	169 (44.1)	0.002
Cardiomegaly	114 (20.7)	51 (13.4)	0.002
Left ventricular hypertrophy	25 (4.5)	10 (2.6)	0.089
Creatinine=1.4-2.5(mg/dl)	37 (6.7)	32 (8.4)	0.196
Hemoglobin<12 (g/dl)	84 (15.1)	44 (11.5)	0.067
Intraoperative risk factors			
Need of perioperative IABP	18 (3.2)	3 (0.8)	0.009
Inotropic agents	233 (41.9)	32 (8.4)	0.000
Dopamine	31 (5.6)	4 (1.0)	0.000
Dobutamine	200 (36.0)	25 (6.5)	0.000
Epinephrine	21 (3.8)	0 (0.0)	0.000
Norepinephrine	13 (2.3)	1 (0.3)	0.007
Amrinone	9 (1.6)	3 (0.8)	0.207
Milrinone	33 (5.9)	1 (0.3)	0.000
Postoperative (ICU) risk factors			
Inotropic agents	151 (27.2)	37 (9.7)	0.000
Beta blocker use	407 (73.2)	340 (88.8)	0.000
AF rate	93 (16.7)	38 (9.9)	0.002
Red blood cell transfusion	84 (15.1)	44 (11.5)	0.067
In-hospital mortality	5 (1.3)	18 (3.2)	0.044

AF= Atrial Fibrillation; CABG= Coronary Artery Bypass Grafting; CCS= Canadian Cardiovascular Society Angina Score; COPD= Chronic Obstructive Pulmonary Disease; CPB= Cardiopulmonary Bypass; CVA= Cerebrovascular Accident; IABP= Intra Aortic Balloon Pump; ICU= Intensive Care Unit; NYHA= New York Heart Association; OPCAB=Off-pump Coronary Artery Bypass Grafting.

categorical variables. Multivariate regression analysis was used to determine the independent characteristics associated with POAF. A *P*-value <0.05 was considered statistically significant. The software SPSS version 19 was used for statistical analysis.

Results

A total of the 939 patients were included in the study. Of these patients, 647 (68.90%) were male and 292 (31.09%) female. The mean age of the patients was 56.5 ± 12.8 years with 234 patients (24.9%) being older than 65 years. The demographic characteristics of patients were summarized in Table 1. On-pump and off-pump CABG procedures were performed in 556 (59.21%) and 383 patients (40.79%), respectively. The mean period of observation during ICU stay was 3.4±2.4 days for off-pump and 4.6±5.1 for on-pump group. POAF occurred in 131 patients (13.45%); 38 patients (9.9%) in the off-pump and 93 patients (16.7%) in the on-pump CABG groups. There was significant difference between two groups considering the incidence of POAF (*P*=0.002).

The relations between the predisposing factors and occurrence of POAF in off-pump and on-pump CABG are outlined in Tables 2 and 3, respectively. Among preoperative risk factors, age>65 years was of a significant association with the incidence of AF in both groups [off-pump 42.1% (*P*= 0.016) vs. on-pump 33.3%, (*P*=0.020)]. When considering hypertension as a predisposing factor, there was no significant difference between hypertensive and non-hypertensive patients in both groups [off-pump (*P*=0.336) vs. on-pump (*P*=0.162)]. Furthermore, in both groups duration of hospital stay was significantly higher in the AF patients compared to those remaining in sinus rhythm (Tables 2, 3).

This study also demonstrated that most cases of the POAF converted to sinus rhythm through correction of electrolyte imbalance and administration of amiodarone (off-pump 94.7% vs. on-pump 82.8%). In addition, in-hospital mortality in on-pump group was significantly greater in patients who developed AF compared to group in sinus rhythm (*P*=0.005), but in off-pump group there was no death in patients who developed POAF.

Table 2. Predisposing factors and rates of postoperative atrial fibrillation in OPCAB patients

Variable	OPCAB with AF (n=38)	OPCAB without AF (n=345)	*P*-value
Female gender	8 (21.1)	93 (27.0)	0.283
Age >65	16 (42.1)	83 (24.1)	0.016
Hypertension	6 (15.8)	42 (121.2)	0.336
Not receiving Beta-blocker	6 (15.8)	64 (18.6)	0.437
Not receiving CC.Blocker	23 (60.5)	228 (66.1)	0.303
ICU stay (day, min±SD)	4.2±2.9	3.3±2.3	0.023
Hospital stay (day, min±SD)	8.0±3.9	7.1±3.2	0.122
In-hospital mortality	0 (0)	5 (1.4)	0.591

AF=Atrial Fibrillation; CC.Blocker= Calcium Cchannel Blocker; ICU=Intensive Care Unit; OPCAB= Off-pump Coronary Artery Bypass Grafting; SD=Standard Deviation

Table 3. Predisposing factors and rates of postoperative atrial fibrillation in CABG patients

Variable	CABG with AF (n=93)	CABG without AF (n=463)	*P-value*
Female gender	60 (64.5)	304 (65.8)	0.450
Age>65	31 (33.3)	104 (22.5)	0.020
Hypertension	10 (10.8)	33 (7.1)	0.162
Smoking	24 (25.8)	178 (38.4)	0.013
Not receiving Beta-blocker	17 (18.3)	132 (28.5)	0.026
Not receiving CC.Blocker	58 (62.4)	337 (72.8)	0.031
CPB time (min, mean±SD)	117.3±44.6	108.5±40.4	0.059
ACC time (min, mean±SD)	67.7±30.4	64.3±29.6	0.309
Cold blood cardioplegia	91 (97.8)	460 (99.4)	0.197
Aortic root reperfusion	62 (66.7)	298 (64.5)	0.393
Topical ice slush	83 (91.2)	425 (92.0)	0.468
Cardiac venting techniques	85 (93.4)	439 (95.0)	0.338
ICU stay (day, mean±SD)	6.4±7.3	4.2±4.4	0.000
In-hospital stay	10.7±7.4	8.9±5.4	0.010

ACC time=Aortic Cross-Clamp time; AF=Atrial Fibrillation; CABG= Coronary Artery Bypass Grafting; CC.Blocker= Calcium Channel Blocker; CPB= Cardiopulmonary Bypass; ICU=Intensive Care Unit; SD=Standard Deviation

Discussion

POAF is a common complication of CABG that occurs in 5-40% of patients during the first postoperative week.[11] Although the cause of POAF in patients undergoing CABG remains unknown, numerous triggering risk factors have been proposed. Several reports have focused on the use of CPB as a significant factor. Only a few researchers have reported an association between bypass time and POAF[12], some reporting lower incidence rates of POAF in patients undergoing off-pump CABG.[3,13,14] It has Yet, there are reports claiming neither off-pump CABG nor on-pump CABG affected the occurrence of POAF.[15,16] Our study was designed to determine if eliminating CPB would lower the incidence of POAF. The results of this prospective study analyzing patients undergoing CABG show that the introduction of an off-pump technique changes the occurrence of POAF. In the present study, POAF developed in 9.9% of the off-pump and in 16.7% of the on-pump CABG; there was significant difference between two groups when considering the incidence of POAF (*P*=0.002), consequently this data demonstrates the effect of CPB on the occurrence of POAF. Decreased rate of AF in patients who have undergone off-pump CABG have also been shown in other studies.[9,17-20] In another study reported by Ascione *et al*.[13], CPB inclusive of cardioplegic arrest was the main independent predictor of POAF in patients undergoing CABG. These findings, however, contrast with those from a more recent trial in which 281 patients undergoing first, elective, isolated CABG.[21]

The pathophysiological mechanisms of POAF have been

the subject of assumptions despite broad investigations highlighting the identification of risk factors for the AF onset. The factors relating to CPB that may be important in the generation of POAF include ischemia during cardioplegic arrest and cannulation.[2,22-24] Both of these problems should in theory be avoided in off-pump. Evidence that CPB has an immunological effect on the degree of inflammatory response and complement activation may be important in the generation of this POAF.[25] In addition, off-pump CABG is associated with a significant reduction in the inflammatory response[7] and in the release of markers of myocardial necrosis compared with on-pump CABG.[8]

Several independent risk factors are able to trigger the development of POAF. Advanced age is believed to be closely associated with the occurrence of AF[26-29]; so far, the only reliable risk factor for an increased incidence of POAF has been age≥ 60 years.[2,4,5,26,30] In this present study, the probability of POAF also increased significantly as the patient's age increased over 65 years of age regardless of the method of myocardial revascularization. It is well documented that aging causes degenerative changes in the atrial myocardium leading to changes in electrical characteristics of the SA and AV nodes and atria and contributing to the fragmentation of the propagating impulse.[31,32]

There are also some reports that β-blockers are effective in preventing POAF[33] and all identified meta-analyses have demonstrated that β-blockers significantly reduced the incidence of POAF.[34-39] Increased sympathetic tone may predispose a patient to POAF and β-blockers target this pathway. Therefore, it seems that use of oral β-blockers both preoperatively and postoperatively prevents AF occurrences in the postoperative patients; however, our findings in on-pump group are in contrast with the similar reports in the literature. We noted an increase in POAF among patients who were on preoperative β-blockers. This finding may be related to the initiation of the β-blockers in the immediate postoperative period after patients were extubated. On the other hand, some studies have shown that the use of preoperative β-blockers and early postoperative withdrawal have been implicated in the etiology of POAF.[40-41] Therefore, reinstitution of β-blocker agent immediately after operation can decrease the incidence of POAF. Furthermore, this finding may demonstrate the effect of CPB on the occurrence of POAF in these patients. This study also showed that most of the POAF cases converted to sinus rhythm after treatment (off-pump 94.7% vs. on-pump 82.8%). Moreover, these findings displayed that conversion to sinus rhythm is significantly more probable in off-pump than in on-pump groups (P=0.006). In addition, this data indicated that in-hospital mortality in patients with POAF was 8.6% and 0% in on-pump and off-pump groups, respectively (P=0.005). Therefore, CPB not only could increase the rate of POAF but also might increase in-hospital mortality in patients with AF.

Conclusion

The results of the present study demonstrated that off-pump CABG, being a less invasive procedure, could reduce the incidence of postoperative AF in patients undergoing surgical myocardial revascularization. Furthermore, conversion to sinus rhythm in off-pump group is significantly more than on-pump group.

Ethical issues: The study was approved by the ethics committee of the university. Written informed consent was obtained from patients prior to the enrollment.

Competing interests: The authors had no competing interests to declare in relation to this article.

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