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Coronary Artery Anatomy and the Occurrence of Atrial Fibrillation After Coronary Artery Bypass Surgery

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Abstract

Background: Atrial fibrillation (AF) is one of the most common complications occurring after cardiac surgeries. The incidence of post-operative AF is increasing continuously over the past decades and it is associated with lengthened hospital stay and risk of stroke.
Objectives: This study was designed to examine the relationship between coronary artery involvement and the occurrence of AF after coronary artery bypass graft (CABG).
Methods: This prospective observational study was to assess the relationship between the coronary artery involvement and the occurrence of post CABG surgery AF. Patients with chronic and paroxysmal AF before surgery were excluded. All patients had a complete evaluation by echocardiography, electrocardiography, and laboratory testing. The patients were monitored for 3 days after surgery and any tachycardia monitored as AF was noted. Patients were also divided into two groups of having post-operative AF and not having AF. Coronary artery involvement was defined using the Rentrop system. The coronary arteries were divided into 14 segments for better understanding of the lesions.
Results: In this study 232 patients were selected, from which 106 patients had AF and 126 patients had sinus rhythm. The results of the present study confirmed that the older patients had a more frequent occurrence of AF after CABG ($P < 0.001$). There was no significant relationship between the right coronary artery (RCA) lesion and the development of AF after CABG. Proximal left anterior descending (LAD) artery lesion was associated with a higher occurrence of AF after CABG ($P = 0.022$). Patients with single vessel or two-vessel coronary artery disease had a more frequent occurrence of AF after CABG versus those with three vessel disease ($P = 0.021$).
Conclusions: Although age has been the most important predictor for occurrence of AF after CABG in the past and present studies, there are many other variables affecting its occurrence. Out of the variables evaluated in this study, higher PAP, proximal LAD lesion, higher levels of BNP, and D dimer as well as single vessel and two vessel coronary artery diseases were noted to significantly predict a higher occurrence of AF after CABG.

Keywords: Atrial Fibrillation, Coronary Artery Anatomy, Coronary Artery Bypass Grafting

1. Background

Atrial fibrillation (AF) occurs in about 20 to 40% of patients after coronary artery bypass graft (CABG) surgery (1, 2). It is one of the most common complications occurring after cardiac surgeries. The incidence of post-operative AF is increasing continuously over the past decades and is possibly due to the aging of the population having cardiac surgeries (3).

Post-operative AF usually occurs 2 - 4 days after the procedure. Although it is generally well tolerated, it can also be life threatening especially in the elderly and patients who suffered from left ventricular dysfunction (4). It is also associated with an increased risk of thromboembolic events (5, 6) and stroke (7), ventricular dysrhythmias and lengthened hospital stay, and an extra cost.

Several studies have been done for predicting the factors affecting the occurrence of AF after CABG, which have shown consistent association with increasing age and the risk of AF after CABG (1, 2, 6). In a study, the left atrium enlargement has also been identified as independent factors for a more frequent occurrence of AF after CABG (8). On the other hand only a few studies have shown no relationship between the left atrium enlargement and the risk of post CABG AF (2, 9, 10). In the past studies, pulmonary artery pressure has not been studied as a factor affecting

post CABG occurrence of AF.

2. Objectives

This study was designed to evaluate the relationship between the extension of coronary artery disease (CAD) and the location of the lesions with the occurrence of AF after CABG. The perioperative data and variables were also analyzed to assess which patients are at a higher risk for developing AF after CABG.

3. Methods

This prospective observational study started from March 2013 until March 2016 and was done to assess the relationship between the coronary artery involvement and the occurrence of post CABG surgery AF. Patients with chronic AF before surgery or history of paroxysmal AF were excluded from the study. Patients were monitored continuously and examined during the 1st through the 3rd day of the post-operative period in the intensive care unit (ICU) for having any form of tachycardia compatible with AF. Patients were selected randomly and divided into two groups of having developed AF and not having AF. The rate control for the patients were done by B-blockers or Ca channel blockers and also if resistant intravenous amiodarone was used. Before and after the surgery, all patients had a complete para clinical workup for electrolyte disturbances, renal function tests, thyroid function tests, lipid profile, and echocardiographic evaluation of the LV function, pulmonary artery pressure, diastolic function, and the LA dimension. One of the most important goals of the study was to determine any relationship between the incidence of AF and the anatomy of the coronary arteries. This was the reason for the angiography film of the patients, which were reviewed by a single cardiologist who did not know whether the patient had AF post-operation or not. The left main and the 3 main coronary arteries were divided into 14 segments used for a better understating of the involvement of the arteries. The first 4 segments were related to the RCA, the fifth segment was the left main artery, the 6 - 10th were LAD artery segments and the last 4 was related to the left circumflex artery. The lesions, which were more than 60%, were marked and were completely occluded and the Rentrop classification was used. Grade 0 Rentrop was defined as no visible filling of any collateral. Grade 1 Rentrop was defined as a presence of collaterals; however the dye does not reach the epicardial segment of the vessel. Rentrop 2 grade is partial collateral filling of the epicardial segment of the vessel being dilated and grade 3 is complete collateral filling of the vessel being dilated. The anatomy of sinoatrial node branch was also seen.

3.1. Para Clinical Evaluation

Echocardiography was done by a Vivid 7 ultrasound system by a single operator for all the patients. Laboratory testing was done using the same laboratory kits and analyzed with the same system.

3.2. Statistics

Data of the patients were recorded in questionnaires and were analyzed using IBM SPSS Statistics 22 for windows (IBM, Corp, Armonk, NY) after data collection. Chi-square and Student's t test were used for determining the relation between the different factors and the occurrence of AF after CABG. The difference between the two groups was considered significant if they had a P value of less than 0.05. Those univariate factors, which had a significant difference, were entered for multivariate logistic regression analysis for assessment of independent correlation with AF.

4. Results

The demographic and laboratory data of the patients in the two groups are summarized in Table 1 and the echocardiographic and angiographic data in Table 2.

In this study 232 patients were selected, from which 106 patients had AF and 126 patients had sinus rhythm. Only two patients underwent off pump CABG. None of the patients had CABG done in an emergent condition. Out of the 232 patients, 46 were female and 186 were male. There was no significant difference in the occurrence of AF in male or females. There was no significant difference between the ejection fraction (EF) and the left atrium dimension of the two groups. There was no significant difference between the renal and thyroid function tests of the two groups. No significant difference existed between the two groups regarding their electrolytes and lipid profile. Prevalence of diabetes mellitus was 30.2% in patients with AF and 31% in patients without AF, which was not significantly different. The prevalence of hypertension was more in patients without AF by 10%, however the difference was not statistically significant ($P = 0.155$).

The results of the study show that patients who were older (mean age of 65 vs. 60) had a significantly higher occurrence of AF ($P < 0.001$).

Patients with higher levels of D dimer (mean value of 1,747 vs. 1,145.5 ng/mL) and brain natriuretic peptide (BNP) (mean value of 2,618.5 vs. 1,595 pg/mL) had a more frequent occurrence of post operation AF ($P = 0.011$ and < 0.001, respectively). There was no significant relationship between the cardiac marker levels and the coronary artery involvement in the patients.

Table 1. Demographic and Laboratory Data of the Patients Studied by Univariate Analysis

	Median (!QR) in AF Patients (N = 106)	Median (IQR) in Non AF Patients (N = 126)	P Value
Age, y	65 (58.75 - 70)	60 (53.75 - 65)	< 0.001
Weight, Kg	75 (70 - 82.75)	74 (65 - 80)	0.063
Hemoglobin, g/dL	13.5 (12.4 - 14.55)	13.5 (12.375 - 14.9)	0.711
Hematocrit (%)	38.95 (36.275 - 42)	39.75 (36 - 43)	0.394
White blood cells, /mL	7700 (6500 - 9000)	7300 (6000 - 8800)	0.176
Platelets, $\times 10^9$/L	215 (179.75 - 258.5)	214.5 (181.5 - 265)	0.803
C reactive protein, mg/L	27.7 (24.75 - 40.25)	30 (20 - 40)	0.908
Blood urea nitrogen, mg/dL	18 (13 - 22)	18 (14 - 20.25)	0.632
Creatinine, mg/dL	0.85 (0.7 - 1)	0.9 (0.8 - 1)	0.631
Low density lipoprotein, mg/dL	79 (61 - 96)	77.5 (60.75 - 104.25)	0.975
High density lipoprotein, mg/dL	36.5 (33 - 43)	37.5 (35 - 45)	0.086
Triglyceride, mg/dL	116.5 (77.75 - 162.5)	116 (80 - 154.5)	0.942
Thyroid stimulating hormone, μIU/mL	1.1(0.675-1.8)	1.2(0.6 - 2)	0.259
Uric acid, mg/dL	5.2 (4.4 - 6.625)	5 (4 - 6.05)	0.366
Troponin, ng/mL	0.01 (0 - 0.01)	0.01 (0.01 - 0.01)	0.849
Brain natriuretic peptide, pg/mL	2618.5 (1350 - 4595)	1595 (926.25 - 3050)	< 0.001
D dimer, ng/mL	1747 (940 - 2378)	1145.5 (775.75 - 1960.25)	0.011
Sodium, mEq/L	140 (137 - 143)	141.5 (138.75 - 144)	0.042
Potassium, mEq/L	4.2 (4 - 4.5)	4.25 (4 - 4.5)	0.569
Magnesium, mEq/L	2 (2 - 2.2)	2 (1.8 - 2.4)	0.056

Abbreviation: IQR, interquartile range.

Table 2. Echocardiographic and Angiographic Data of the Patients Studied by Univariate Analysis[a]

	Median (IQR) in AF Patients (N = 106)	Median (IQR) in Non AF Patients (N = 126)	P Value
Ejection fraction (%)	45 (35 - 55)	45 (33.75 - 50)	0.125
PAP, mmHg	26.5 (20 - 35)	20 (15 - 30)	< 0.001
LA diameter	3.4 (3.1 - 3.8)	3.4 (3.1 - 3.7)	0.493
3 vessel disease, cm	85 (80.2)	115 (91.3)	0.021
Left main	8 (7.5)	3 (0.3)	0.403
LAD-proximal part	43 (40.5)	33 (27.5)	0.022
LAD-non proximal part	68 (62.4)	86 (68.3)	0.557
RCA-proximal part	28 (26.4)	21 (16.7)	0.093
RCA-non proximal part	51 (48.1)	66 (32.4)	0.693
LCX-proximal part	35 (33)	44 (34.9)	0.739
LCX-non proximal part	44 (41.5)	54 (42.8)	0.779

Abbreviations: PAP, pulmonary artery pressure; LA, left atrium; LAD, left anterior descending artery; RCA, right coronary artery; LCX, left circumflex artery; IQR, interquartile range.
[a]Values are expressed as No. (%).

Both univariate and multivariate analysis showed significant relationships between a more frequent occurrence of AF after CABG and higher pulmonary artery pressure (PAP) (mean value of 26.5 vs. 20 mmHg) in the patients (P < 0.001 and 0.01, respectively).

4.1. Coronary Anatomy and Lesion

Regarding the coronary artery anatomy and the occurrence of AF after CABG, both univariate and multivariate analysis showed significant relationships between the involvement of proximal LAD and having a single and two-vessel disease with the occurrence of post-operative AF (P values 0.022 and 0.021 respectively). Branching of sinoatrial node artery from the left system was also studied, which showed no significant difference in the two groups.

The results of the multivariate analysis for coronary artery involvement and EF are summarized in Table 3.

Patients that were using the maximum tolerable

Table 3. Data of the Patients Studied by Multivariate Analysis

	Beta Coefficient	P Value	OR (CI 95%)
3 vessel disease	-6.11	0.004	0.543 (0.358 - 0.823)
Ejection fraction	0.027	0.125	1.027 (0.993 - 1.06)
LAD-proximal part	0.001	0.021	1.3 (1.1 - 1.4)

Abbreviations: OR, odds ratio; CI, confidence interval.

dose of angiotensin converting enzyme inhibitors or angiotensin receptor blockers had less of an occurrence of post-operative AF (P value 0.013). Patients taking high dose statin had a less occurrence of AF after CABG in comparison to those not taking statin or taking it with a lower dosage (P value 0.007). Pre-operative use of beta blockers did not affect the rate of occurrence of AF after CABG.

5. Discussion

The present study confirmed the higher occurrence of AF after CABG in older patients and also showed that patients with higher levels of BNP and D dimer had a higher occurrence of AF after surgery. Furthermore, it was also shown that patients who had a higher PAP were more at risk of having AF after CABG. In regards to the coronary artery involvement and the risk of AF the present study showed that patients with involvement of proximal LAD and single or two-vessel disease had higher occurrence of AF after surgery.

Similar to other studies (8, 9), the present study confirmed that with aging there is a higher occurrence of AF after CABG. The fibrosis and dilatation of atria has been shown to increase with age (11), which causes consequent slowing in the conduction of atrial muscle fibers, which may be a possible cause for the increase in the occurrence of AF (12).

There was also a relationship between higher levels of BNP and D dimer with the occurrence of AF after CABG, which was significant by univariate analysis, which could be due to the more inflammatory involvement of the left atrium chamber. This finding should be confirmed by more studies in the future as it may be a confounding finding as the relationship was not found to be significant by multivariate logistic regression analysis.

In the present study, both univariate and multivariate analysis showed significant relationships between higher PAP and the occurrence of AF after CABG. Although the clear mechanism is not known, patients with higher PAP also have a more diastolic dysfunction, which may be a contributing factor for the occurrence of AF.

There was no protective role for the preoperative administration of beta-blockers in our study, which was similar to the results of the study done by Golmohammadi et al. in 2008 (13).

In regards to the involvement of coronary arteries and the occurrence of AF after CABG, previously RCA stenosis was identified as an independent factor for predicting AF after CABG (7). In another study presence of RCA occlusion with proximal LAD, stenosis was not identified as a risk factor for atrial fibrillation (14). In a study done by Ducceschi, three-vessel coronary artery disease was identified as an independent factor predicting AF occurrence after coronary artery surgery. In the present study, similar to the results of the study done by Zaman et al. (10), we did not find any significant relationship between the involvement of RCA and the occurrence of AF after CABG, which was against the results presented by Mendes et al. (7). In contrary to the results of the study done by Ducceschi, our findings showed there is significantly a higher occurrence of AF after CABG in patients with single vessel and two-vessel coronary artery disease rather than three-vessel coronary artery disease. Proximal LAD lesion was not stated to be an independent factor predicting AF occurrence after CABG in most of the studies however, our study signified the relationship between proximal LAD lesion and post-operative AF. Several findings in our study was concordant to the studies done before but the differences seen in the results of the stated studies may be due to the different operative procedures and also to not knowing the arteries grafted during the CABG. As there may be lesions in different arteries, they may be not suitable for grafting and not grafted during the surgery. Other aspects that may lead to these discrepancies include differences in patient characteristics and demographics surveyed, sample size, number of risk factors in the multivariate model, and monitoring techniques.

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