Predictors of Postoperative Atrial Fibrillation after Heart Valve Surgery

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Abstract

Background- Atrial fibrillation (AF) is the most common complication after cardiac surgery and a major cause of morbidity and increased cost of care. Suitable treatment and prevention of postoperative AF are important for patients' improved health and rehabilitation. This study evaluates the risk factors of paroxysmal AF in patients who underwent valvular heart surgery.

Method- Between April and October 2006, 392 patients who underwent heart valve surgery at our center were included in this prospective study. All relevant clinical, echocardiographic, and laboratory data were gathered in all the patients.

Results- Postoperative AF occurred in 52 (13.3%) patients. In the univariate analysis, the presence of aortic valve disease, mitral valve disease, dyslipidemia, preoperative digoxin consumption, postoperative adrenergic use, intra-aortic balloon pump (IABP) insertion in post-surgery intensive care unit, and large left atrium were significantly associated with the occurrence of postoperative AF (all P<0.05). However, in the stepwise logistic regression model, dyslipidemia (OR: 2.39, 95% CI: 1.12-5.09, P=0.020), left atrium dimension (OR: 0.12, 95% CI: 0.76-0.28, P<0.001), IABP (OR: 7.10, 95% CI: 1.98-25.47, P=0.001), preoperative digoxin use (OR: 2.55, 95% CI: 1.38-4.71, P=0.002), postoperative adrenergic use (OR:3.70, 95% CI: 1.77-7.73, P<0.001), aortic valve replacement (OR:0.38, 95% CI: 0.20-0.69, P=0.0001), and mitral valve replacement (OR:3.53, 95% CI: 1.75-7.10, P<0.001) remained independently predictive of postoperative AF.

Conclusions- The result of this study showed that dyslipidemia, left atrium dimension, mitral valve replacement, aortic valve replacement, IABP, and adrenergic use in ICU and digoxin use preoperatively were the independent predictors of AF after valvular surgery. Therefore, clinical data and echocardiography may be useful in preoperative risk stratification of high-risk patients for the occurrence of postoperative AF***(Iranian Heart Journal 2008; 9 (2):10-17).***

Key words: atrial fibrillation ■ postoperative arrhythmia ■ heart valve surgery

Atrial fibrillation (AF) is one of the most common complications after cardiac surgery.[1,2] The incidence of arrhythmia has not changed despite improvements in anesthetic and surgical techniques, and evidence suggests its incidence may be increasing.[3]

According to previous publications, it occurs in 10 to 65% of patients after cardiac surgery.[1-8]

The rate of AF after cardiac surgery in 1970 was about 10% and is now consistently at least 30% and much higher in that undergoing heart valve surgery.

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Although AF is considered a serious problem, acknowledgement of AF as a potentially serious arrhythmia has recently increased.
AF usually occurs 2-4 days after surgery[1,3] and often returns during the first 30 days of the postoperative period.[1]
In a minority of cases, it may result in inappropriate tachycardia, hypotension, heart failure, and a possible increase in the risk of cerebrovascular accidents.[3]

Methods

Between April 2006 and October 2006, 392 consecutive patients who were scheduled to undergo valvular heart surgery were included in our study. The study was approved by the local ethics committee, and written informed consent was obtained from all the patients. Previous history of AF or atrial flutter rhythm, use of antiarrhythmic drugs other than beta-blockers, uncontrolled heart failure, end-stage renal disease, and presence of an implanted pacemaker were the exclusion criteria. Patients were also excluded if they underwent any operation other than heart valve surgery or if sustained ventricular tachyarrhythmia, or cardiogenic shock, or death in the operating room occurred. For each patient, a form including data related to the preoperative and postoperative periods was completed. A standard 12-lead ECG, transthoracic echocardiography, laboratory tests, and blood pressure measurement were performed in all the patients.
A careful medical history including sex, age, risk factors (hypertension, diabetes, dyslipidemia, and cigarette smoking), drug history (antiarrhythmics, anticoagulants, and antiplatelet agents), history of previous cardiac surgery (valvular or non-valvular) was taken, and echocardiographic data including left ventricular end-diastolic diameter (LVEDD), left ventricular end-systolic diameter (LVESD), and left atrial diameter (LAD) were registered. In the postoperative state, the patients were followed first in the ICU for at least 3 days and then in the surgical wards. The type of surgery (AVR, MVR, TVR, PVR, and multivalvular), duration of ICU admission, use of IABP and adrenergic drugs, and BUN/Cr status were registered.

Postoperative care

After the operation, the patients were followed-up in the ICU and were weaned off the ventilator when they fulfilled the following criteria: hemodynamic stability, peripheral temperature >32°C, cooperativity, and no major bleeding. Chest drains were removed on the first postoperative day, and the patients were moved to the surgical ward. All the patients were continuously monitored postoperatively during the ICU stay. After transfer to the ward, all the patients were connected to monitors for continuous ECG monitoring up to the fifth postoperative day. The ward monitor stored the ECG recordings for subsequent analyses. The recordings were analyzed off-line. A 12-lead ECG recording was done, if necessary, to confirm AF episodes. One electrophysiologist and one cardiology fellow who were blinded to other data reviewed these data on a daily basis. Preoperative beta-blockers, calcium channel blockers, and digoxin were continued for the entire hospital stay.
The endpoint of the study was the occurrence of the new-onset AF during the first five days following valvular surgery. AF was defined as absent P waves before the QRS complex, together with irregular ventricular rhythm on the rhythm strips. Only AF episodes lasting longer than 5 minutes were counted. Abnormal P-wave morphology is defined as P-wave duration of more than 110 ms with inter-peak notch of more than 40 ms and duration of terminal negative P-wave deflection in lead V1 of more than 40 ms.

Statistical analysis

All the continuous variables are presented as mean±SD. The other variables are presented in the percentage of population having a specific value. We tested the association of

pre-, intra-, and postoperative variables with the occurrence of postoperative AF by using the student t-test for the normally distributed continuous variables and Mann-Whitney U-test for those without a normal distribution. Chi-square tests and Fisher's exact probability test (when appropriate) were used for the categorical variables. We included all the parameters, which showed a $P < 0.1$ during bivariable correlation to our model of binary logistic regression analysis to determine the independent characteristics associated with postoperative AF. A P-value <0.05 was considered statistically significant. The software SPSS version 13.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis.

Results

Three hundred and ninety-two patients who underwent heart valve surgery were included in the analysis. The baseline characteristics are shown in Table I. All the patients had normal sinus rhythm. Of these patients, 188 (48%) were male and 204 (52%) were female. The mean age was 44±15 yrs (range 16 to 78 yrs) at the time of study.

Table I: Baseline characteristic of AF and non-AF groups

Characteristics	AF (n=52)	No AF (n=340)	P value
Age (yr); mean±SD	48	44±15.19	0.016
Male / Female	32.7 / 67.3	50.1 / 49.9	0.019
MVD n (%)	75	51.9	0.002
AVD n (%)	40.4	62.2	0.003
TVD n (%)	3.8	5.9	0.547
PVD n (%)	1.9	5.9	0.236
HTN n (%)	15.4	18.3	0.611
DM n (%)	15.4	8.3	0.098
DLP n (%)	21.2	10.1	0.020
C/S n (%)	9.6	16.8	0.186
History of surgery n (%)	34.6	24.2	0.109

MVD=mitral valve disease; AVD=aortic valve disease; TVD= tricuspid valve disease; PVD= pulmonary valve disease; HTN= hypertension; DM= diabetes mellitus; DLP=dyslipidemia; C/S= cigarette smoker

Seventy (17.9%) patients had HTN, 45 (11.5%) had dyslipidemia, 36 (9.2%) had diabetes, and 61 (15.6%) were smokers. One hundred and one (25.8%) patients had a history of prior cardiac surgery, including 76 (19.4%) valve surgery and 25 (6.4%) non-valvular heart surgery. Thirty-three (8.4%) patients had abnormal BUN and creatinine levels, 23 (5.9%) had received preoperative calcium channel blockers, 148 (37.8%) beta-blockers, 62 (15.8%) anticoagulants, 92 (23.5%) digoxin, and 101 (25.8%) antiplatelet agents preoperatively. In the postoperative period, 41 (10.5%) patients received adrenergic drugs and 10 (2.6%) patients had IABP inserted. The mean ICU admission time was 3.77 days. The mean LVEDD, LVESD, and LA diameter were 52±10.2, 37±9.7, and 41±8.4 mm, respectively (Table II).

Table II: Preoperative echocardiography findings of AF and non-AF groups

Characteristics	AF (n=52)	No AF (n=340)	P value
Left Ventricular End Diastolic Diameter (mm) ±SD	50±11	52±10	0.355
Left Ventricular End Systolic Diameter (mm) ±SD	35±9.4	37±9.8	0.257
Left Atrial Diameter (mm) ±SD	46±0.79	41±0.83	0.000

Aortic valve replacement (AVR) was done in 146 (37.2%) patients, mitral valve replacement (MVR) in 136 (34.7%), pulmonary valve replacement (PVR) in 18 (4.6%), tricuspid valve replacement (TVR) in 6 (1.5%), MVR+AVR in 62 (15.8%), TVR+PVR in 2 (0.6%), MVR+PVR in 1 (0.3%), MVR+TVR in 4 (1.1%), and MVR+AVR+TVR in 1 (0.3%).

Overall, 52 (13.3%) patients developed AF during the postoperative period. The mean age was similar in the AF and Non-AF groups.

History of HTN, diabetes mellitus (DM) and cigarette smoking did not differ significantly between the two groups. HTN was detected in 15.4 percent of the AF group and 18.3% of the non-AF group (P=0.61). History of DM was present in 15.4% of the AF group and 8.3% of the non-AF group (P=0.09). Additionally, 9.6% of the AF group were smokers, while 16.8% of the non-AF group smoked (P=0.18). Dyslipidemia was detected in a higher percentage of the patients with AF compared with those without AF (21.2% vs. 10.1, P=0.02). LVEDD (50±11mm in AF and 52±10mm in the non-AF group, P=0.35) and LVESD (35±9mm in the AF and 37±9mm in the non-AF group, P=0.25) did not significantly differ between the two groups. However, the left atrium was significantly larger in patients with AF than that of the non-AF group (46±7.9mm vs. 41±8.3mm, P<0.0001). Pre- and postoperative levels of BUN and creatinine did not show any significant difference between the two groups. IABP was inserted in 9.6% of the patients with AF and 1.5% of those without AF (P<0.001). Duration of ICU stay in the AF group was significantly greater than that in the non-AF group (4.7±2.6 vs. 3.6±1.8, P=0.001). Antiplatelet and anticoagulant therapy had no relation with AF occurrence (P=0.88 and P=0.053, respectively). AF was significantly more common in patients with a history of digoxin consumption (40.4% vs. 20.9%, P=0.002, Table III).

Table III: Postoperative characteristic of AF and Non-AF groups

Characteristics	AF (n=52)	No AF (n=340)	P value
IABP n (%)	9.6	1.5	0.001
MVR n (%)	78.8	51.3	0.000
AVR n (%)	36.5	60.2	0.001
TVR n (%)	1.9	3.5	0.545
PVR n (%)	1.9	5.3	0.290
Adrenergic drugs use n (%)	25	8.3	0.000
ICU admission Duration (day) n (%)±SD	4.7 ±2.6	3.6 ±1.8	0.001

Antiarrhythmic drugs use did not show any difference between the two groups (50% vs. 41%, P=0.22). Adrenergic use in the postoperative state remained independently predictive of postoperative AF (P=0.0001, Table IV).

Table IV: Predictors of postoperative AF

Characteristics	Odds Ratio	95% Confidence Interval	P value
IABP	7.10	1.98-25.47	0.001
Adrenergic drugs	3.70	1.77-7.73	0.000
LAD	0.12	-0.76 - -0.28	0.000
DLP	2.39	1.12-5.09	0.020
AVR	0.38	0.20-0.69	0.001
MVR	3.53	1.75-7.10	0.000
AVD	0.41	0.22-0.74	0.003
MVD	2.77	1.43-5.39	0.002
Digoxin	2.55	1.38-4.71	0.002

IABP=intra-aortic balloon pump; LAD=left atrial diameter; DLP=dyslipidemia; AVR=aortic valve replacement; MVR=mitral valve replacement; AVD=aortic valve disease; MVD=mitral valve disease

Discussion

Postoperative AF after cardiac surgery is a growing problem.[4] Nearly 800,000 cardiac surgical procedures are performed annually in the United States. Despite the continued trends for patients undergoing these procedures to be of higher-risk and older than in the past, operative mortality remains low and has declined in some series on a risk-adjusted basis. In this setting, increased attention is being paid to perioperative complications as an important source of patient morbidity and health-care resource utilization. Postoperative AF is one of the most frequent complications of cardiac surgery, and this arrhythmia is the focus of intense investigative efforts as a means for improving patient outcomes.[9]

The rate of AF after cardiac surgery in the 1970s was about 10%, and now is consistently at least 30% (between 5-65%), being much higher in older patients or those undergoing valve surgery.[10-23] Although AF is always considered a problem,

acknowledgement of AF as a potentially serious arrhythmia has increased; there have been more than 100 trials, multiple metaanalyses, and three sets of practice guidelines for the prevention of postoperative AF in cardiac surgery.[4,5]

Although reports[5,14] indicate that AF occurs within four days[1,2,5] postoperatively, it can occur at any point in the recovery period. According to Steven et al.,[6] AF is a common complication after MVR surgery, occurring in one of four patients without a prior history of AF and in sinus rhythm at surgery. In addition, early AF (within the first 2 weeks after operation) occurs more frequently after MVR than repair, and is associated with a high late recurrence rate.[5]

Although outpatient monitoring with cardiac event recording is useful in detecting asymptomatic episodes of AF, monitoring all patients after discharge may not be cost effective.[2] Other investigators[13-21,22-35] have evaluated risk factors for postoperative AF. Age over 65 yrs, history of intermittent AF, use of atrial pacing in the postoperative period, male sex,[10] white race, IABP, [9] and not having hyperlipidemia were independent predictors of AF.[2] However, others have found that HTN,[3] left atrial dimension,[2,6,9] creatinine clearance,[1,36] postoperative withdrawal of beta-blockers, chronic obstructive pulmonary disease, history of myocardial infarction, history of cardiopulmonary bypass, cross-clamp times, postoperative respiratory compromise,[2,9] mechanical ventilation more than 24 hours,[9] and intraoperative and postoperative application of adrenergics[1] are significantly associated with postoperative AF.

We excluded patients with a history of AF in our study. In previous investigations,[27-29] patients with a history of AF were excluded because they were expected to be at greater risk. Other researchers[13,33,37] have also found that patients with a history of AF are at an increased risk for postoperative AF. Mathew et al.[29] found that a history of AF increased the risk of AF in the postoperative state approximately 2-fold, and Margorine et al.[2] showed this risk to be about 6-fold. In contrast, Deliargyris et al.[4] reported that postoperative AF was 19 times more likely in patients with a history of AF than in those without such a history.

Male sex has inconsistently been associated with postoperative AF. Some researchers[50, 54, 56] have found that being male is associated with AF, whereas others[14, 25] have not. Our study chimed in with the latter. Creswell et al.[12] reported a significant relationship between real ethnicity and postoperative AF. Our study showed that dyslipidemia is an independent risk factor. Marjorie et al.[2] suggested that not having hyperlipidemia was an independent predictor of postoperative AF. No previous investigators have examined the presence or absence of hyperlipidemia as a predictor of AF. In addition, a double-blind study showed that prophylactic treatment with atorvastatin significantly lowered the incidence of AF after open heart surgery.

The development of AF after cardiac surgery results in a longer stay in the ICU and in the hospital, together with a significantly higher (two-to three-fold) risk of postoperative stroke.[38-40] Postoperative AF has also been shown to predict postoperative delirium and neuro-cognitive decline.[4,41,42] Increasing age is the most consistent predictor of postoperative AF.[2,4,21,23-35] Age-related changes in the atria such as dilation, muscle atrophy, and decreased conduction may explain the strong association. Some authors have reported an increasing incidence of AF in recent years,[12] which may be attributed, at least in part, to the frequent use of continuous postoperative rhythm monitoring, the rapid improvement of anesthesia and surgical technology, and major advances in the practice of percutaneous coronary revascularization procedures, resulting in the referral of significantly older and sicker patients to cardiac surgery compared to patients referred for open-heart surgical procedures 10 years ago.

Since increasing age has been a consistent independent predictor for AF after cardiac surgical procedures[2,12] referral of older patients for open-heart surgery results in a higher incidence of AF postoperatively.[2] Twenty-nine trials have evaluated the length of stay,[4] and three trials[5] have tested multiple interventions. Only amiodarone and pacing had a significant effect on the length of stay.[4,43] Also, amiodarone was the only single intervention that showed a significantly reduced stroke rate, Ninety-four trials of prevention of postoperative AF have been identified by standard search methods and analyzed by standard meta-analysis techniques. All five commonly tested interventions, beta-blockers, sotalol, amiodarone, magnesium, and atrial pacing were effective in preventing AF.[4] Despite the existence of unique guidelines from the American Heart Association, European Society of Cardiology, and American College of Cardiology, there are still doubts as to the selection of the best antiarrhythmic drugs, timing of therapy, duration of treatment, and prevention of renewed occurrence.[1] Similar to prior reports, we found a significant relation between postoperative AF and postoperative adrenergic use. Salaria et al.[36,44] investigated the influence of postoperative adrenergic use in 199 patients after cardiac surgery. These investigators showed that adrenergic use was an independent predictor of postoperative AF (OR 3.35, 95% CI: 1.38-8.12, P=0.016). Our study showed dyslipidemia as an independent predictor of postoperative AF (OR 2.39, 95% CI: 1.12-5.09). Recent studies in widely varied populations emphasize the role of left atrial size as a major marker of adverse cardiovascular events.[6,44] Left atrial dimension was a predictor of postoperative AF in our study. Ascher et al. attributed the greater susceptibility to AF after valve surgery to structural and hemodynamic abnormalities, such as left atrial enlargement and pathologic changes in the atria.[3,9]

Conclusions

The results of the present study demonstrated that IABP, postoperative adrenergic use, left atrial dimension, dyslipidemia, AVR, MVR, mitral valve disease, aortic valve disease, and digoxin use preoperatively were independent predictors of AF after valvular surgery. Therefore, clinical data, discontinuation of digoxin, and treatment of dyslipidemia may be useful in the preoperative risk stratification of high-risk patients for the occurrence of AF.

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