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Atrial Fibrillation Post Coronary Artery Bypass Grafting Surgery Incidence and Risk factors

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Cardiothoracic surgery

Atrial Fibrillation Post Coronary Artery Bypass Grafting Surgery Incidence and Risk factors

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ABSTRACT

Background: Atrial fibrillation is a common complication following cardiac surgery, especially coronary artery bypass grafting. Although this condition mostly benign but it can increase mortality and morbidity postoperative and leading to longer ICU stay and increase the costs.
Aim of the study: to investigate and analyse the atrial fibrillation incidence and risk factors in patient undergoing CABG in addition to its effect on intensive care unit and postoperative hospital stay.
Patients and Methods: Our study was retrospective non-randomized. Between January 2018 and January 2020, 50 patients were recruited from a total of 225 patients who underwent coronary artery bypass graft surgery at Al-Azhar University Hospitals. In these 50 cases, we studied their risk factors that were possibly connected to the development of atrial fibrillation post CABG surgeries.
Results: In our study, the rate of POAF was 22.22 percent, with 50 patients out of 225 underwent isolated CABG operations over the course of two years. Our findings show that old age, a history of hypertension, smoking, low ejection fraction, a dilated left atrium, longer bypass time, early ischemic changes in ECG and low potassium level are all predictors of atrial fibrillation after Coronary Artery Bypass Grafting.
Conclusion: Atrial fibrillation is the most frequently occurring arrhythmic complication post cardiac surgery. Around 10%–60% of patients undergoing coronary artery bypass graft and valvular surgery experience new-onset atrial fibrillation. Although it is a benign complication, it may contribute to mortality, morbidity, and prolongs the ICU stay, and elevates the hospitalization costs.

Keywords: *AF post CABG; Atrial Fibrillation; Coronary Artery Bypass Grafting.*

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INTRODUCTION

The most frequent arrhythmia after cardiac surgery is atrial fibrillation. Its reported frequency is 15–40%, a considerable increase in occurrence when compared to the general population. [1]

Postoperative AF is more common in patients who have had valve surgery or combination valve and coronary artery bypass grafting than in patients who have had CABG alone. [2]

In most situations, postoperative atrial fibrillation is self-limiting, but if it is uncontrollable, it necessitates extra medical therapy and a longer hospital stay, increasing the expense of operational treatment.[3]

Postoperative arrhythmias are rather common following open cardiac surgeries. Supraventricular rhythm disorders, such as atrial fibrillation and atrial flutter, account for the majority of these irregularities. Postoperative AF was considered a benign, transient, and self-limited arrhythmia having no consequences. However, as more data from multiple studies has accumulated, it has become clear that POAF is a significant factor contributing to higher postoperative morbidity and mortality.[4]

The most prevalent complications following cardiac surgery are atrial fibrillation and/or atrial flutter. After a coronary artery bypass graft, 25-40% of patients get postoperative AF (POAF), and 50-60% after valvular surgery. Among individuals having CABG and concurrent valve surgery, POAF is most commonly occurring at a rate of 62 percent. Patients

who have had a heart transplant have the lowest rate of POAF. POAF is increasingly prevalent as a result of the growing number of older individuals undergoing cardiac surgery.[5]

Postoperative atrial fibrillation (POAF) events are most common on days 2-3 after surgery, and within the first four days, around 70% of all episodes occur. The third postoperative day is the most common day for POAF recurrence. Within two days of the initial POAF episode, approximately 60% of all recurrences occur. POAF, on the other hand, can happen at any time following surgery. The most common reason for hospital readmission after an early hospital discharge post-heart surgery is atrial fibrillation.[6]

It's uncertain how often atrial fibrillation is after heart surgery. The reported incidences range from 10% to 65%. Due to the fact that studies assessing atrial fibrillation following coronary artery bypass grafts varied in terms of baseline patient characteristics, AF criteria, operation types, and detection methods, the range is wide.[6]

The incidence is projected to climb in the future because patients become older, and the atrial fibrillation incidence generally depends on age.[3]

Several studies have identified risk factors for developing atrial fibrillation post cardiac operations.[7]

Atrial fibrillation is linked to conditions like advanced age, previous attacks AF, male gender, diabetes mellitus, COPD, chronic renal failure, low ejection fraction, left atrial enlargement, and rheumatic heart disease.[8]

Some studies found that males are more prone than females to develop POAF, while others found no difference.[9]

Hypertension, as a primary risk factor, appears to predict atrial fibrillation after cardiac surgery, which could be connected to fibrosis and atrial refractoriness dispersion.[10]

POAF will transition to sinus rhythm in the vast majority of patients within 24 hours of operation.

Modification of predisposing variables such as anemia, hypoxia, and electrolyte imbalance must be the first line in managing POAF in hemodynamically stable patients.[11]

Cardioversion by direct current (ECV) or pharmacologically with amiodarone should be pursued in the case of hemodynamically unstable patients. Electrical direct current shock is also indicated if the patient exhibits severe symptoms or if rate control is hard to achieve.[12]

PATIENTS AND METHODS

The current study was carried out from January 2018 to January 2020. In this study, 50 patients were chosen from total of 225 patients who underwent Coronary artery bypass graft surgeries attending Al-Azhar University Hospitals during the time of the study. In these 50 cases, we studied their risk factors possibly associated with developing postoperative atrial fibrillation and its effect on intensive care unit and hospital stay after surgery. The study included patients with any primary native patient who underwent isolated CABG surgery.

We exclude patients known to have any form of preoperative documented atrial arrhythmia, patients having valve diseases, patients who underwent previous open-heart surgeries, patients with pacemaker devices or implantable defibrillators, patients who underwent off-pump CABG surgeries, patients with dilated left atrium.

Patients were subjected preoperatively to a detailed history was taken, as regards the age, sex, a complete clinical general and cardiological examination was performed. And investigated by complete blood count, liver function tests, prothrombin time, concentration and INR, kidney function tests, fasting blood sugar, 12 leads ECG, erect poster anterior plain chest x-ray, Two-dimensional echocardiography, and Doppler color flow for assessment of EF, LVED, LVES, LA, right ventricle, Coronary angiography, and Preoperative counseling.

Intra-operative data including Cross clamp and total bypass times, cardioplegia solution: type, doses, and space between each dose, the lowest temperature on bypass and number of grafts and type, right coronary artery or posterior descending artery involvement. Postoperative data including Mechanical supports, e.g. Ventilator and intra-aortic balloon pump, ventilation hours and ICU hospital stay days, and chemical supports, e.g. Adrenaline and noradrenaline, ECG ischemic changes, e.g. ST-segment elevation or hyperacute T-wave, blood gases, e.g. serum k levels, lactate level, blood glucose level, Chest X-ray, Postop. Complications e.g. Bleeding and thromboembolic complications, e.g. Acute limb ischemia, transient ischemic attacks, and cerebrovascular stroke Wound infection, pleural collection, phrenic nerve injury, pericardial effusion, lung collapse.

Development of POAF as detected by 12 leads electrocardiogram monitoring and defined as any documented AF of more than 5 minutes in duration or for any length of time requiring intervention for angina or hemodynamic compromise.

Statistical analysis: The statistical program for social sciences, version 20.0, was used to analyze the data (SPSS Inc., Chicago, Illinois, USA). To express quantitative data, the mean and standard deviation

(SD) were used. The frequency and percentage of qualitative data were used to represent the data.

RESULTS

Our study included 50 AF patients out of 225 eligible patients.

Regarding to age, there was 13 females (26%) and 37 males (74%) in the AF group. As regard age, there were 20 patients (40%) < 55 years, 30 patients (59%) ≥ 55 years in the AF group (Table 1).

Demographic data		AF group (n=50)
Gender	Female	13 (26.0%)
	Male	37 (74.0%)
Age (years)	<55 years	20 (40.0%)
	≥55 years	30 (60.0%)

Table 1: Gender and age in AF group.

According to co-morbidities in the AF group. DM was present in 28 patients (56%), HTN was present in 40 patients (80%), COPD was present in 17 patients (34%), there were 12 smoker patients (24%) and 8 Ex-smokers (16%), thyroid disease was present in 10 patients (20%), previous MI was present in 19 patients (38%), and history of CKD was present in 14 patients (28%) (Figure 1, Table 2).

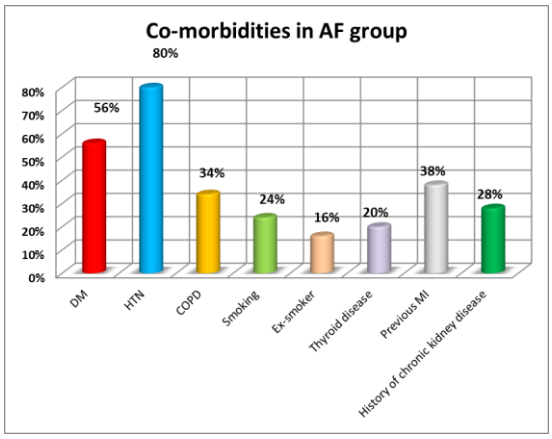

Fig 1: co-morbidities (DM, HTN, COPD, smoking, thyroid disease, previous MI and history of chronic kidney disease) in AF group.

According to preoperative drugs in POAF. Twenty-three patients (46%) received beta-blockers, while the other 27 patients (54%) had no rate control drugs (Table 3).

According to LA diameter and EF% in POAF. As regard LA diameter, it was < 40 in 22 patients (44%) and ≥ 40 in 28 patients (56%). As regard EF%, it was ≤ 50% in 30 patients (60%) and > 50% in 20 patients (40%) (Table 4).

As regards RCA dominance, it was non-dominant in 20 patients (40%) and dominant in 30 patients (60%). As regards RCA grafting, it was done in 23 patients (46%) and not done in 27 patients (54%) (Table 5).

According to CCT, bypass, cardioplegia, DC shocks, and temperature on the bypass in POAF. As regard CCT, it was ≤ 60 in 20 patients (40%) and > 60 in 30 patients (60%). As regard Bypass, it was ≤ 110 in 22 patients (44%) and > 110 in 28 patients (56%). As regards DC shock, it was done in 19 patients (38%) and not done in 31 patients (62%). As regard temperature on bypass, it was ≤ 30 in 35 patients (70%) and > 30 in 15 patients (30%) (Table 6).

According tpostoperative K+ anpostoperative ECG in POAF. As regard post-operative k^+, it was ≤ 3.5 in 33 patients (66%) and > 3.5 in 17 patients (34%). As regarpostoperative ECG, it was ischemic in 23 patients (46%) and non-ischemic in 27 patients (54%) (Table 7).

According to hospital stay regarding ventilation, surgery and ICU stay days in POAF. As regard ventilation time, it was ≤ 10 hours in 27 patients (54%) and > 10 hours in 23 patients (46%). As regards the surgery type, it was elective in 34 patients (68%) and emergency in 16 patients (32%). As regards ICU stay, it was ≤ four days in 20 patients (40%) and > 4 days in 30 patients (60%) (Table 8).

According to the Distribution of atrial fibrillation cases according to their postoperative day, AF occurred. It was 1 day in 7 patients (14%), 2 days in 13 patients (26%), 3 days in 13 patients (26%), 4 days in 6 patients (12%), 5 days in 4 patients (8%), 6 days in 2 patients (4%) and 7 days in 1 patient (2%) while there were 4 patients (8%) developed POAF immediately. The mean postoperative days AF occurred were 2.5 ± 1.51 days with maximum day of 7 days (Table 9).

In the present study, POAF occurred in 22.22% of patients (50 out of 225 patients) who underwent isolated CABG surgery, as shown in (Figure 2, Table 10)

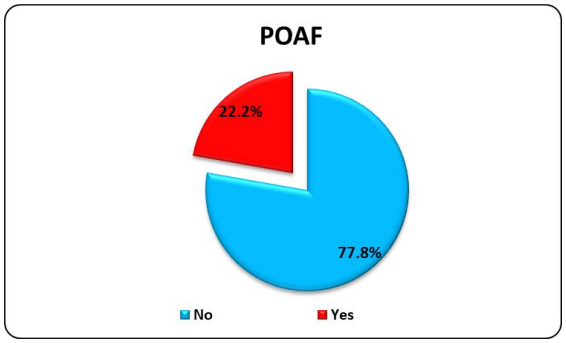

Fig 2: Incidence of atrial fibrillation.

Co-morbidities		AF group (n=50)
DM	No	22 (44.0%)
	Yes	28 (56.0%)
HTN	No	9 (18.0%)
	Yes	40 (80 %)
COPD	No	30 (60.0%)
	Yes	17 (34.0%)
Smoking	No	31 (62.0%)
	Yes	12 (24.0%)
	Ex-smoker	8 (16.0%)
Thyroid disease	No	40 (80.0%)
	Yes	10 (20.0%)
Previous MI	No	30 (60.0%)
	Yes	19 (38.0%)
History of chronic kidney disease	No	36 (72.0%)
	Yes	14 (28.0%)

Table 2: Co-morbidities (DM, HTN, COPD, smoking, thyroid disease, previous MI and history of chronic kidney disease) in AF group.

Drugs	AF group (n=50)
Other rate control or No rate control drugs at all	27 (54.0%)
Beta blockers	23 (46.0%)

Table 3: description of preoperative drugs in POAF.

Echo data		AF group (n=50)
LA diameter	<40	22 (44.0%)
	≥40	28 (56.0%)
EF%	≤50%	30 (60.0%)
	>50%	20 (40.0%)

Table 4: Description of preoperative drugs in POAF.

Coronary disease		AF group (n=50)
RCA dominance	Non dominant	20 (40.0%)
	Dominant	30 (60.0%)
RCA grafting	No	27 (54.0%)
	Yes	23 (46.0%)

Table 5: Description of RCA dominance and RCA grafting in POAF.

Operative data		AF group (n=50)
CCT	≤60	20 (40.0%)
	>60	30 (60.0%)
Bypass	≤110	22 (44.0%)
	>110	28 (56.0%)
DC shocks	No	31 (62.0%)
	Yes	19 (38.0%)
Temperature on bypass	≤30	35 (70.0%)
	>30	15 (30.0%)

Table 6: Description of CCT, bypass, cardioplegia, DC shocks and temperature on bypass in POAF.

Investigations		AF group (n=50)
Postop K+	≤3.5	33 (66.0%)
	>3.5	17 (34.0%)
ECG post-op	No ischemia	27 (54.0%)
	Ischemia	23 (46.0%)

Table 7: Description of post-operative K+ and post-operative ECG in POAF.

Hospital stays		AF group (n=50)
Ventilation hours	≤10	27 (54.0%)
	>10	23 (46.0%)
Type of Surgery	Emergency	16 (32.0%)
	Elective	34 (68.0%)
ICU stay days	≤4 days	20 (40.0%)
	>4 days	30 (60.0%)

Table 8: Description of hospital stay regarding ventilation, surgery and ICU stay days in POAF.

		Total (n=50)
Postop day AF occurred	0 days	4 (8%)
	1 day	7 (14%)
	2 days	13 (26%)
	3 days	13 (26%)
	4 days	6 (12%)
	5 days	4 (8 %)
	6 days	2 (4%)
	7 days	1 (2%)
	Range [Mean±SD]	0 - 7 [2.50±1.51]

Table 9: Distribution of atrial fibrillation cases according to their postoperative day AF occurred (n=50).

POAF	No.	%
No	175	77.78
Yes	50	22.22
Total	225	100.00

Table 10: Incidence of atrial fibrillation.

DISCUSSION

Around one-third of patients who undergo cardiac surgery develop atrial fibrillation, which is associated with an increase in adverse events across all quantitative outcomes of care, as well as an increase in hospital resource use and, as a result, the cost of care.[1]Postoperative atrial fibrillation is the most prevalent arrhythmia post cardiac surgery. This arrhythmia is becoming more frequent as a result of an increase in the number of older people receiving cardiac surgery. It's uncertain how often POAF is after heart surgery. The reported incidences range from 10% to 65%. Due to the fact that the studies assessing AF following CABG varied in terms of baseline patient characteristics, AF criteria, operation types, and detection methods, the range is wide. POAF is estimated to occur in roughly 30% of patients following pure CABG surgery, 40% following valve replacement or repair, and approximately 50% following combined CABG and valvular surgeries.[14]

In our study, the rate of POAF was 22.22 percent, with 50 patients out of 225 underwent isolated CABG operations over the course of two years. The incidence of POAF was 22.22 percent in this investigation, which matched the findings. According to the most recent STS data report[15], 24.9 percent of patients who underwent coronary artery surgery developed new onset of atrial fibrillation. The factors underlying the AF onset following heart surgery are still unknown. Pericardial inflammation, transcellular fluid and electrolyte shifts, metabolic abnormalities, catecholamine elevation, autonomic discord, and atrial stretch are all believed to play a role in causing atrial fibrillation either alone or in concert. The atrial refractory period is shortened as a result of these circumstances, which slows atrial conduction. The atrioventricular node is excited as a result of the re-entry wavelets, causing fast and irregular ventricular contractions.[16]

POAF has been linked to increased risk of ICU readmission, longer intensive care unit stay, longer hospital stay, and higher hospital expenses in studies.

Detecting a population who are at increased risk of POAF allows for more targeted preventive and therapeutic measures that would decrease the overall cost.

In our study, we targeted 50 cases who developed new-onset atrial fibrillation post coronary artery surgeries.

In the current study, atrial fibrillation peak incidence was in the second day postoperative then the third day postoperative. Similar results were obtained in a study POAF most commonly occurs in the 2nd and 3rd days postop, respectively.[17] In another study, before the end of postoperative days 4 and 6, 70 percent and 94 percent of CABG patients developed POAF, respectively.[18]

In our study, we found that old age was an extremely important risk factor for POAF. Elderly patients (esp. above 55years) were more likely to develop POAF than younger ages with a significant p-value (0.01). Also, males were more susceptible to develop POAF than females in our study. According to Aranki et al., old age and male gender were risk factors for atrial fibrillation following CABG. [18]

Also, Leitch et al. found that age represents the most important independent prognosticator of atrial fibrillation.[19] Per decade of advanced age, the incidence increases by at least 50%.[19]In the general population, older age also predicts atrial fibrillation, probably due to greater atrial fibrosis and dilatation.[20]Men tend to be more prone than women to develop atrial fibrillation after CABG.[21]

The incidence of POAF was just 0.8 percent in patients under the age of 50 who received CABG (which made up 8.7% of our sample). OPCAB was found to be linked to a lower risk of POAF among men and in patients younger than 65 years.[22]

According to one study, there is a 75 percent rise in the risk of having AF for every ten years of age. After 50 years, we discovered a considerable increase in the occurrence of POAF with each passing decade: 1.8 percent in patients under the age of 50, 10.79 percent in those between the ages of 50 and 59, 19.25 percent in those between the ages of 60 and 69, 28.22 percent in those between the ages of 70 and 79, and 50 percent in those over the age of 80.[5]

The onset of POAF is linked to a number of risk factors classified as: preoperative, intraoperative, and postoperative. An increased risk of atrial fibrillation was associated with advanced age, smoking, left ventricular enlargement, and renal impairment in preoperative patients.[23]

In our study, 24% of patients who experienced POAF were smokers, which represents a significant finding. Because these smokers may have COPD, they frequently have ventilation-perfusion (V/Q) mismatch, resulting in arterial hypoxemia. Poor ventilating mechanics and atelectasis of the lungs can increase the V/Q mismatch following surgery.[23]

In our study, there is a great relationship between hypertension and POAF. More than 75% of POAF cases were hypertensive. In a study by Patel et al., it showed that history of hypertension is predictive for POAF, hypertensive heart commonly associated with left ventricular hypertrophy and myocardial fibrosis, which can provide a proper substrate for generation of POAF[24], which can be related to the concomitant fibrosis and dispersion of atrial refractoriness[6]

Patients who had a history of diabetes mellitus showed an insignificant difference in the development of postoperative atrial fibrillation.[23] However, Echahidi et al. reported that diabetes mellitus and metabolic syndrome are associated with POAF[25], the study reported by Tsai et al. revealed that diabetes mellitus is a significant risk factor fopostoperative atrial fibrillation.[26]

Some studies revealed preoperative renal dysfunction as a predictor opostoperative atrial fibrillation because of ischemia, atheroembolism, and systemic inflammation[27]. This was similar to the result of Tsai and colleague.[26]However, in our study, preoperative renal impairment is not a significant risk factor for developing POAF.

Patients with POAF have a large left atrium diameter as compared with patients without POAF in the present study. Similar to the previous report, Echahidi et al. showed that enlarged left atrium represents a risk factor for developing POAF[25], which was similar to the findings of Mostafa and colleague[28], as POAF risk has been linked to atrial hypertrophy prior to surgery. POAF following CABG was also predicted by preoperative refractoriness dispersion and a large PR delay. Uncontrolled ventricular rate and congestive heart failure have been linked to atrial stretch, apoptosis, and myolysis, resulting in atrial structural abnormalities.

Benjamin et al. demonstrated that congestive heart failure predisposes to atrial fibrillation.[29] This is consistent with our findings that patients having lower ejection fractions were predisposed to POAF more than patients with higher ejection fractions. Mostafa et al. demonstrated that a history of heart failure is a preoperative risk factor for POAF development.[28] Also, Sanders et al. found that those with congestive heart failure are more vulnerable to AF because they have a longer p-wave, a longer sinus node recovery time, and a longer refractory period at the right atrial wall. As a result, prolonged conduction time is connected to significantly disrupted substrates, as is in the case of longer iso-electric intervals and a higher percentage of double potentials. Chronic dilated atria, a result of congestive heart failure, appear to be the cause of these pro-arrhythmic alterations.[30]

Some studies[30] demonstrated that Patients with previous ischemic insults or a history of myocardial infarction were more vulnerable to develop POAF than other ones, and this may be related to poor left ventricular function, dilated dimensions, and myocardial ischemia.

Prolonged cross-clamp time and prolonged cardiopulmonary bypass time were two intraoperative variables linked to POAF. Cardiopulmonary bypass restricts blood flow to the heart, which can lead to atrial ischemia-reperfusion damage and POAF. Prolonged procedure times were linked to an increased risk postoperative atrial fibrillation in certain studies. Also cross-clamp time has been related to POAF.[31]POAF was also discovered to be more common in patients who had extended bypass and cross-clamp periods. Due to prolonged periods of ischemia and insufficient atrial protection with current cardioplegia procedures, it was hypothesized that atrial ischemia was most likely

the cause of AF in vulnerable patients. Several studies back this notion, showing that extended cardiopulmonary bypass and cross-clamp periods are independent predictors of atrial fibrillation.[32]

These results agreed with that postoperative atrial fibrillation is the outcome of repeated re-entry wavelets caused by "atrial refractoriness dispersion." An atrial structural substrate is required for dispersion of atrial refractoriness. Old age, obesity, diabetes, hypertension, left atrial enlargement could all have a role. During and after surgery, surgical atrial damage and atrial ischemia may also lead to the formation of the structural substrate. Inflammation, oxidative stress, and hereditary factors are all thought to play a role. Once these conditions are present, an activating event, such as a premature atrial contraction, electrolyte imbalance, and/or increased adrenergic or vagal activation, will induce postoperative atrial fibrillation.[33]

Hypokalemia is a risk factor for postoperative arrhythmia[34]. In the current study, hypokalemia was a significant risk factor in patients who experienced POAF. Serum potassium levels in patients with POAF was (3.47±0.58).

In the study reported by Hashemzadeh and colleagues, inotropic use was an important risk factor for developing postoperative atrial fibrillation.[23]

ECG early postoperative showing ischemic changes, e.g., ST-segment elevation and hyperacute T-wave, is also a predictor for POAF. This may be attributed to atrial ischemia that affects atrial refractoriness and conduction.

Intensive care unit (ICU) stay duration was increased with patients who experienced POAF in our study. This finding is supported by several studies.[23] This is caused to a circulatory standstill in the left atrium, which causes an embolus to occur.[34]

Ventilation hours in ICU and Intra-aortic balloon pumps are factors that didn't much affect the risk of POAF, as shown in our study.

Patients who developed atrial fibrillation following surgery were much less likely to be on beta-blockers than those who did not develop AF. According to the findings of this study, preoperative beta-blockers that are taken throughout the pre-and postoperative periods decrease postoperative atrial fibrillation.

CONCLUSION

Atrial fibrillation is the most prevalent arrhythmic consequence following heart surgery. About 10% to 60% of patients who undergo coronary artery bypass graft and valvular surgery experience new-onset atrial fibrillation. Although it is a benign complication, it can increase mortality, morbidity, duration of ICU stays, and hospital costs.

In our study, we found that low ejection fraction, dilated left atrium, hypertension, smoking, old age, male gender, prolonged bypass time, prolonged cross-clamping time, renal impairment, previous myocardial infarction, low temperatures on bypass, early ischemic changes postoperative, hypokalemia, use of adrenaline and noradrenaline, all of these factors were found to be significant predictors for developing atrial fibrillation after cardiac surgery.

To lower the incidence of postoperative AF, the well-known preoperative risk factors can be treated before surgery

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