

## Risk factors for postoperative atrial fibrillation in cardiac surgery

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The authors declare no competing interests

### Acronyms

**AF:** atrial fibrillation  
**CPB:** cardiopulmonary bypass  
**LVEF:** left ventricle ejection fraction  
**POAF:** postoperative atrial fibrillation

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### ABSTRACT

**Introduction:** The advent of new techniques of percutaneous intervention, the optimization of pharmacological behavior and the use of new surgical techniques (conventional, minimally invasive and video-assisted) have resulted in ever more difficult cases being treated in the operating room with an increase in the incidence of postoperative atrial fibrillation.

**Objectives:** To analyze the association among some variables and the incidence of this arrhythmia in cardiovascular surgery.

**Method:** A retrospective analysis was conducted with the last 100 patients of both sexes, aged 18 and over, operated in the Cardiovascular Surgery Service of CIMEQ Cardiology Hospital, between October 2008 and February 2010. 27 variables arranged in four groups were analyzed and their relationship with postoperative atrial fibrillation was determined.

**Results:** 37% of the patients analyzed presented this type of atrial fibrillation, which was more frequent in patients with mixed (80%) and double valve disease (66.66 %). Of the clinical variables only previous atrial fibrillation, mitral valve disease, age over 65, hemodynamic instability, previous myocardial infarction and III or IV functional class were significant. None of the studied electrocardiographic variables were significantly associated with the occurrence of postoperative atrial fibrillation. All echocardiographic variables (dilated left ventricle and atrium, dilated right atrium and ejection fraction below 55 %), and six of the variables that are typical of surgery (cardiopulmonary bypass, recovery from cardiac arrest in atrial or ventricular fibrillation, use of amines in trans or postoperative period, over 120 minutes of aortic clamping, double valve disease and mixed cases) were significantly associated with the occurrence of this arrhythmia.

**Conclusions:** The clinical variables highly associated with atrial fibrillation are less significant than the variables typical of surgery, in the case of postoperative atrial fibrillation.

**Key words:** Atrial fibrillation, Heart surgery, Postoperative, Risk factors

## Factores de riesgo de fibrilación auricular posoperatoria en cirugía cardíaca

### RESUMEN

**Introducción:** El advenimiento de nuevas técnicas de intervencionismo percutáneo, la optimización de las conductas farmacológicas y el empleo de nuevas técnicas quirúrgicas (convencionales, mínimamente invasivas y video-asistidas) han traído como resultado que casos cada vez más difíciles lleguen a los quirófanos, con un incremento en la incidencia de la fibrilación auricular posoperatoria.

**Objetivo:** Analizar la asociación de algunas variables con la incidencia de esta arritmia en la cirugía cardiovascular.

**Método:** Se realizó un análisis retrospectivo de los últimos 100 pacientes, de ambos sexos y mayores de 18 años, operados en el Servicio de Cirugía Cardiovascular del Cardiocentro CIMEQ, en el periodo de octubre de 2008 a febrero de 2010. Se analizaron 27 variables organizadas en cuatro grupos y se determinó su relación con la fibrilación auricular posoperatoria.

**Resultados:** El 37 % de los pacientes analizados presentó este tipo de fibrilación auricular, que fue más frecuente en pacientes con enfermedad mixta (80 %) y doble valvular (66,66 %). De las variables clínicas sólo fueron significativas la fibrilación auricular previa, la valvulopatía mitral, la edad mayor de 65 años, la inestabilidad hemodinámica, el infarto miocárdico previo y la clase funcional III ó IV. Ninguna de las variables electrocardiográficas estudiadas se asoció de forma significativa a la ocurrencia de fibrilación auricular posoperatoria. Todas las variables ecocardiográficas (dilatación de ventrículo y aurícula izquierdos, dilatación de aurícula derecha y fracción de eyección menor de 55 %), y seis de las variables propias de la cirugía (empleo de circulación extracorpórea, salida de paro en fibrilación auricular o ventricular, uso de amins en el trans o el posoperatorio, pinzamiento aórtico mayor de 120 minutos, enfermedad doble valvular y casos mixtos) se asociaron significativamente a la aparición de esta arritmia.

**Conclusiones:** Las variables clínicas con alta asociación a la fibrilación auricular, tienen menor peso que las variables propias de la cirugía, en el caso de la fibrilación auricular posoperatoria.

**Palabras clave:** Fibrilación auricular, Cirugía cardíaca, Posoperatorio, Factores de riesgo

### INTRODUCTION

Atrial fibrillation (AF) is the most common arrhythmia in clinical practice<sup>1</sup>. It was recognized from the mid-nineteenth century and because of its totally irregular rhythm it was called *delirium cordis*. It was not until 1899 that this arrhythmia was related to an electrophysiological alteration known as AF. Ten years later, in 1909, Lewis described its electrocardiographic features for the first time in humans<sup>2-4</sup>.

It is a supraventricular tachycardia characterized by loss of cyclic and ordered activation of the atria, which is replaced by a disorganized and continuous activity. Small atrial areas are simultaneously depolarized, leading to a loss of organized atrial contraction. This uncoordinated atrial activation leads to deterioration

of mechanical function and in the electrocardiogram rapid oscillations or fibrillatory waves that vary in amplitude, shape and range, replacing the P waves are observed; as well as a rapid irregular ventricular response in the presence of an intact conductive tissue<sup>5,6</sup>. This response depends on the electrophysiological properties of the atrioventricular node and other conducting tissues, vagal and sympathetic tone, the presence or absence of accessory pathways and drug action<sup>6,7</sup>. The genesis of this arrhythmia is related, in general, with chronic factors of each patient acting as substrate (heart disease) and acute factors acting as triggers<sup>8,9</sup>.

Postoperative atrial fibrillation (POAF) is the most common complication after cardiac surgery. According

to the practice guidelines of the European Society of Cardiology, in a systematic review of 58 studies involving over 8,000 patients, this arrhythmia occurs in approximately 30 % of cases after CABG, 40 % after valve surgery and 50 % after combined CABG and valve replacement<sup>5</sup>, and leads to high morbidity and high health costs<sup>1,10,11</sup>. Postoperative atrial fibrillation not only has prognostic implications, but also an important economic load<sup>12,13</sup>.

In this study, the frequency of some preoperative variables typical of cardiovascular surgery, related to the incidence of postoperative atrial fibrillation for three years, was analyzed at the CIMEQ cardiology hospital. The behavior of clinical, electrocardiographic and echocardiographic variables was analyzed in the preoperative period as well as the behavior of the variables typical of cardiovascular surgery and the postoperative period that could be related to postoperative atrial fibrillation.

**METHOD**

A retrospective analysis was conducted with the last 100 patients of both sexes, aged 18 and over, operated in the Cardiovascular Surgery Service of CIMEQ Cardiology Hospital, between October 2008 and February 2010. 27 variables arranged in four groups were analyzed and their relationship with postoperative atrial fibrillation was determined.

Patients who were classified into the group of permanent AF or who were in AF at the time of surgery were excluded from the study. Indeed, other classes of AF (the one diagnosed for the first time, paroxysmal, persistent and long-term persistent) that were not fibrillating at the time of surgery were included.

To identify variables related with postoperative atrial fibrillation the medical records of patients operated by the surgical team in the period described were analyzed. These variables are divided into four groups as follows:

- Clinical variables: age, sex, existence of previous AF, according to the New York Heart Association (NYHA) functional classification, hemodynamic instability, mitral valve disease, hypertension, diabetes mellitus, pulmonary hypertension, obesity and previous myocardial infarction.
- Electrocardiographic variables: supraventricular extrasystoles, atrioventricular block, wide QRS and abnormal morphology of the P wave.
- Echocardiographic variables: left and right atrial di-

lation, left ventricle dilation and left ventricle ejection fraction (LVEF).

- Variables typical of cardiovascular surgery: prolonged aortic clamping, cardiopulmonary bypass (CPB), recovery from cardiac arrest in AF or ventricular fibrillation, use of amines in trans or postoperative period, emergency surgery, previous cardiac surgery, mixed and double valve disease cases.

For data and variables analysis the SPSS statistical package for Windows XP, version 15.0 was used. The chi-square statistical method was used to determine the correlation between variables and their statistical significance, and linear regression test to analyze their associations. The relationship of some independent predictors with postoperative atrial fibrillation in the final model was expressed by the odds ratio with a confidence interval of 95%.

**RESULTS**

Of the 100 cases studied, 37 presented postoperative atrial fibrillation (37.00%). Their distribution according to the underlying disease that led them to the operating room is shown in **Table 1**. Patients with coronary (29.54 %) and valve disease (46.34 %) were those who most often developed arrhythmia.

**Table 2** shows the behavior of the clinical variables. Previous AF (81.81 %), mitral valvulopathy (75%), age over 65 years (59.37 %), hemodynamic instability (58.06 %), previous infarction (54.83 %) and III or IV functional class (43.66%) were significantly associated with the development of POAF. In this series we found that patients who had POAF were 65 ± 10.2 years old, while those who did not have the disorder were 54 ±

**Table 1.** Distribution of cases according to underlying disease and the appearance of POAF.

Diagnosis	Total	POAF	%
Coronary	44	13	29,54
Valve	41	19	46,34
Mixed	5	4	80,00
Double valve	3	2	66,66
Congenital	1	0	0,00
Others	6	0	0,00
Total	100	37	37,00

8.7 years.

The behavior of the electrocardiographic variables is shown in **Table 3**. These variables were the least related to the incidence of POAF and none of them was significantly associated with the onset of the arrhythmia.

The echocardiographic variables (**Table 4**) were more closely related to the incidence of POAF and all had a statistically significant association ( $p < 0.01$ ) with

the appearance of POAF. The dilated left (64,10 %) and right (60 %) atria were those that with the highest percentage stimulated the development of AF.

The variables typical of cardiovascular surgery had the highest association with the appearance of POAF (**Table 5**), and also among each other. Only emergency surgery (50 %,  $p = 0.496$ ) and previous heart surgery (33.33 %,  $p = 0.811$ ) lacked associated with the appearance of POAF.

**Table 2.** Behavior of clinical variables associated with POAF.

Clinical variables	Nº of cases	POAF	%	p
Previous AF	11	9	81,81	0.000*
Mitral valvulopathy	20	15	75,00	0.000*
Age over 65 years	32	19	59,37	0.001*
Hemodynamic instability	31	18	58,06	0.003*
Previous infarction	31	17	54,83	0.006*
III or IV NYHA	71	31	43,66	0.031*
Pulmonary hypertension	32	15	46,87	0.161
Diabetes mellitus	21	10	47,61	0.257
Male gender	74	27	36,48	0.515
Hypertension	55	21	38,18	0.787
Obesity	22	8	36,36	0.944

\*  $p < 0.05$

**Table 3.** Behavior of electrocardiographic variables associated with POAF.

Electrocardiographic variables	Nº of cases	POAF	%	p
Atrioventricular block	14	3	21,42	0.481
Supraventricular extrasystoles	17	6	35,29	0.695
Abnormal morphology of the P wave	7	3	42,85	0.739
Wide QRS	17	6	35,29	0.873

**Table 4.** Behavior of echocardiographic variables associated with AF.

Electrocardiographic variables	Nº de casos	FAPO	%	p
Left ventricle dilation	36	20	55,55	0.000*
Left atrial dilation	39	25	64,10	0.000*
LVEF < 55 %	26	12	46,15	0.039*
Right atrial dilation	15	9	60,00	0.045*

$p < 0.05$

In the statistical analysis of the duration of CPB and anoxic arrest (aortic clamping) as POAF independent variables it was found that patients who presented an arrhythmia had a CPB time ( $123 \pm 55.9$  vs.  $86 \pm 21.7$  minutes) and cardiac arrest ( $92 \pm 30.9$  vs.  $55 \pm 11.9$  minutes) higher than those who did not develop arrhythmias. In addition to the univariate chi-square analysis, a logistic regression on all variables of the patients studied (**Table 6**) was performed. Using CPB increases 30.4 times the risk of POAF. The presence of these six variables in the same patient (use of CPB and amines in trans or postoperative period, age over 65, left ventricular dilation, myocardial infarction and LVEF less than 55 %) is associated in a 96, 27 % with the appearance of POAF.

## DISCUSSION

Today AF is the most common sustained arrhythmia in the human heart and also the most clinically diagnosed in ambulatory and hospitalized patients<sup>1</sup>. It is the cause of about one-third of hospitalizations for cardiac rhythm disturbances. The development of AF increases the risk of cardiovascular and cerebrovascular complications, reduces survival<sup>6,14,15</sup>, doubles mortality and increases five times the risk of stroke in relation to the hemodynamic abnormalities and thromboembolic phenomena it produces<sup>16-18</sup>.

Although approximately 30-45 % of

**Table 5.** Behavior of the variables typical of surgery associated with POAF.

Variables typical of surgery	Nº de casos	FAPO	%	p
CPB use	41	25	60,97	0.000*
Recovery from cardiac arrest in atrial or ventricular fibrillation	29	18	62,06	0.000*
Trans or postoperative amines	39	25	64,10	0.000*
Aortic clamping > 120 min	13	9	69,23	0.003*
Double aortic disease	3	2	66,66	0.021*
Mixed cases	5	4	80,00	0.041*
Emergency surgery	6	3	50,00	0.496
Previous cardiac surgery	9	3	33,33	0.811

p < 0.05

**Table 6.** Relative risk of developing POAF according to some variables.

Variable	Risk
CPB use	30,479
Use of trans or postoperative amines	17,605
Age over 65	11,224
Left ventricle dilation	10,322
Acute myocardial infarction	9,938
LVEF < 55 %	9,173

cases of paroxysmal AF and 20 - 25 % of persistent AF occur in young patients without demonstrable disease<sup>19</sup>, with the passage of time an underlying disease that causes AF may appear<sup>20</sup>.

Among cardiovascular diseases associated with AF the following can be noted: valvulopathies, especially mitral, heart failure, ischemic heart disease and hypertension, which becomes more relevant in the presence of left ventricular hypertrophy<sup>1</sup>. Other heart diseases, such as mitral valve prolapse with or without regurgitation, calcification of the mitral annulus, *cor pulmonale*, and idiopathic dilation of the right atrium, have also been associated with a high incidence of AF<sup>6</sup>.

The most frequent acute triggers are alcohol intake, myocardial infarction, pericarditis, myocarditis, pulmonary embolism, hyperthyroidism, after cardiac surgery and acute infection of the respiratory tract, although in about 80 % of cases the presence of AF

is associated with structural heart disease<sup>1,8,9</sup>.

Although this is a generally self-limited event, it exposes the patient to the risk of suffering heart failure, severe hypotension, cardiogenic shock and embolic accidents, which often requires some kind of therapeutic, pharmacological or electrical intervention and anticoagulation when lasting more than 48 hours<sup>13</sup>.

Villareal et al.<sup>21</sup> claim that AF is the most frequently occurring arrhythmia in the postoperative period of a surgical myocardial revascularization. It is one of the most common complications after cardiac surgery and thoracic

surgery in general, and gets to affect approximately 30% of patients, especially in the first days of the postoperative period with increased morbidity and hospital stay<sup>1</sup>. According to Archbold and Schilling<sup>22</sup> it appears between 20 and 40% of patients undergoing this type of surgery and can reach up to 65 %, as reported in a meta-analysis published in the *Annals of Internal Medicine*<sup>1,23</sup>.

Although AF is not a "malignant" arrhythmia, POAF after surgical myocardial revascularization is associated with increased hospital mortality and the onset of stroke; it also prolongs hospital stay and is an independent predictor of mortality in the long term<sup>1,24</sup>.

The dilation of the left atrium and a lower peak atrial systolic mitral annular velocity (a wave) have been associated with development of POAF<sup>25-27</sup>.

Regarding risk factors related to its occurrence, advanced age has been one of the most found, just like the effects typical of surgery, use of CPB, changes in sympathetic tone, the syndrome of low perioperative cardiac output and infections<sup>1,25,27</sup>.

The changes produced by surgery are hemodynamic, physical and chemical in nature. The most outstanding ones are organ perfusion with continuous (not pulsating) laminar flow; contact of blood with foreign surfaces, such as oxygenator and circuits; hypothermia, hemodilution and inhibition of coagulation systems<sup>26-28</sup>, among others.

The cardiovascular surgery in itself generates direct cardiac structural damage, as produced by cannulation of the vena cava, the opening of the atria, and dissec-

tions of the valve annulae, among others; and indirect, as produced by the edema and surgical manipulations. This structural damage is also responsible for the changes that occur after CPB and in the early hours of the postoperative period. These mechanisms explain, in turn, the occurrence of disturbances in contractility and cardiac rhythm<sup>29</sup>.

Many series have shown that POAF prolongs hospital stay from 1-5 days and that it can turn into one of the most costly complications, not only for its incidence but also because it represents 13% of readmissions in the first month<sup>1,12,13</sup>. Prevention or correction of POAF is directly reflected in morbidity and mortality, and in the statistics of patients' survival.

## CONCLUSIONS

The electrocardiographic variables analyzed were not associated with the appearance of POAF. In contrast, echocardiographic, clinical and those variables typical of surgery were. The latter were the most related to the onset of such arrhythmia.

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