Original Research Article

Postoperative clinical outcome of aortic valve surgery in elderly patients and the effect of advanced age on atrial fibrillation: a comparative retrospective study

Ferhat Borulu*, Umit Arslan, Eyupserhat Çalik, Bilgehan Erkut

Department of Cardiovascular Surgery, Faculty of Medicine, Atatürk University, Erzurum, Turkey

*Correspondence:
Dr. Ferhat Borulu,
E-mail: fborulu@gmail.com

ABSTRACT

Background: This study was conducted to evaluate the clinical outcomes of aortic valve surgery in elderly patients and to determine the factors associated with atrial fibrillation.

Methods: Between 2011 and 2015, 54 patients who underwent isolated aortic valve replacement for aortic stenosis without preoperative arrhythmia were divided into two groups as 50-69 years old (group I; n=25) and 70 years and older (group II; n=29). Patient's medical record was retrospectively reviewed. Pre, peri and post operation data was compared. The deaths that occurred in the first 30 days were evaluated as mortality and complications as morbidity.

Results: Mortality rate was found 9.2% (5/54) (p=0.358) in the first 30 days and 8.1% (4/49) the first six months follow-up and no difference was found between the two groups (p=0.153). The following parameters were observed in group 2 and were found statistically significant: average age (p<0.01), euroscore (p<0.01), duration of cardiopulmonary bypass (p<0.01), duration of mechanical ventilation (p<0.01), duration of stay in intensive care unit (p<0.01), duration of stay hospital (p=0.01), acute renal failure (p=0.03), the need for dialysis (p<0.01), atrial fibrillation (p=0.04), pneumonia (p=0.03) and pleural fluid (p=0.01). We found that new-onset atrial fibrillation associated with advanced age (p=0.02), hypertension (p=0.04), duration of cardiopulmonary bypass (p=0.03), duration of aortic cross-clamp (p<0.01), postoperative anaemia (p=0.04), high creatinine values (p<0.01) and cerebrovascular events (p<0.01).

Conclusions: Mortality rate was found 9.2% (5/54) (p=0.358) in the first 30 days and 8.1% (4/49) the first six months follow-up and no difference was found between the two groups (p=0.153). The following parameters were observed in group 2 and were found statistically significant: average age (p<0.01), euroscore (p<0.01), duration of cardiopulmonary bypass (p<0.01), duration of mechanical ventilation (p<0.01), duration of stay in intensive care unit (p<0.01), duration of stay hospital (p=0.01), acute renal failure (p=0.03), the need for dialysis (p<0.01), atrial fibrillation (p=0.04), pneumonia (p=0.03) and pleural fluid (p=0.01). We found that new-onset atrial fibrillation associated with advanced age (p=0.02), hypertension (p=0.04), duration of cardiopulmonary bypass (p=0.03), duration of aortic cross-clamp (p<0.01), postoperative anaemia (p=0.04), high creatinine values (p<0.01) and cerebrovascular events (p<0.01).

Keywords: Aortic stenosis, Aortic valve replacement, Advanced age, Atrial fibrillation, Mortality

INTRODUCTION

Nowadays, because of the high incidence of symptomatic aortic valve diseases, elderly patients are evaluated more in terms of operation.[1] Although aortic valve surgery is a risk factor for morbidity and mortality in elderly patients, long-term results are satisfactory.[2] Bleeding, infection, stroke, arrhythmia, and respiratory pathologies such as respiratory failure and prolonged mechanical ventilation are the most common causes of morbidity.[3] Atrial

fibrillation (AF) remains the most common form of arrhythmia after cardiovascular operations with a rate of 10-65%.[4] Despite the surgical techniques and pharmacological advances, the aging of the population, the increase in the number of operations and easier to identify by advanced monitoring methods contributes to the prevalence of AF. AF increases the morbidity rates, prolong hospital stay and health expenditures. There is no certain information about the incidence of AF after aortic valve surgery and is not sufficiently discussed as in other cardiac operations.[5] Although there are not many studies on this subject, Dumani et al showed that early complications such as mortality, low cardiac output, pulmonary complications, bleeding, atrial fibrillation and wound infection were more frequent in patients with patient-valve mismatch, but this did not have an effect on mortality.[6] In a study by Hernandez et al early complications, including atrial fibrillation, were found to be high in patients with valve incompatibility.[7]

This study aims to present the clinical results of isolated aortic valve surgery in elderly patients and the factors affecting AF development compared to younger patients.

METHODS

In between 2011-2015, 54 patients who underwent isolated aortic valve replacement due to aortic stenosis without preoperative arrhythmia in our clinic were retrospectively evaluated. The study was approved by the local ethics committee. However, because it was a retrospective study, consent was not obtained from the patients. The patients were divided into two groups as group I (n=25 and 50-69 years) and group II (n=29 and 70 years and older). Patients aged 70 years and over were defined as advanced age group. Medical history and physical examination findings of the patients were recorded, euroscore-II (http://www.euroscore.org/) values were calculated, daily electrocardiography (ECG), echocardiography (ECHO) and coronary angiography were performed.

Exclusion and inclusion criteria

Patients undergoing other simultaneous cardiac surgery such as coronary artery bypass grafting (CABG), aortic dissection, patients with reoperations, emergency operations, patients with carotid artery disease, stroke, arrhythmia, infective endocarditis, renal failure and dialysis were excluded from the study. Patients who underwent isolated aortic valve replacement surgery with an ejection fraction of 40% or more were included.

Surgical procedure

All patients were anesthetized with anaesthetic agents routinely applied in our clinic. All patients were operated by conventional sternotomy and standard cardiopulmonary bypass (CPB). A non-pulsatile cylinder pump with membrane oxygenator was used. Cardiopulmonary bypass was performed in moderate hypothermia (rectal temperature 32-34^{0}C) and mean arterial pressure 60-80 mmHg. Cardiac arrest was achieved with antegrade and then retrograde cold blood cardioplegia and mechanical aortic valve replacement was performed with individual pledged sutures (St Jude Medical; St Paul, Minn). CPB and aortic cross clamp (ACC) durations of the patients were recorded.

Postoperative follow-up

In the postoperative period; 24-hour drainage amount (milliliter=ml), duration of mechanical ventilation (DMV; hour), intensive care unit (ICU) and hospital stay (DHS) were recorded. Deaths within the first 30 days were accepted as hospital mortality. The presence of motor deficits lasting more than 48 hours and loss of consciousness lasting more than 12 hours were defined as cerebrovascular events. AF was defined as irregular heart rhythm without 'p' wave in ECG. For the detection of AF, 24-hour 12-lead ECG was performed in ICU and service follow-up, routine ECG in outpatient follow-up after discharge, and 24-hour Holter monitoring in patients suspected from AF. New-onset AF was accepted as operation-related AF within 30 days postoperatively. Amiadarone infusion was given to the patients who developed AF after the operation and the tablet form was continued in the follow-up. Warfarin 5 mg/day treatment was started on the first postoperative day. The warfarin dose was regulated so that the international normalization ratio (INR) values were in between 2.0-3.0.

Statistical analysis

All statistical calculations were done using the SPSS version 17; (Chicago, IL, USA) for Microsoft Windows. Data were statistically expressed in terms of the mean±standard deviation (SD), a frequency (number of cases), or a percentage when appropriate for all the continuous variables. The difference in continuous variables was analyzed using unpaired student's t test. Categorical variables between the two groups were compared using the chi-square (χ^2) test, corrected by the Fisher's exact and Mann-Whitney test when appropriate. The effects of continuous variables were univariately evaluated with Pearson's correlation test or with Wilcoxon rank sum tests. The relationship between each variable and the development of postoperative AF was evaluated by a logistic regression analysis. Statistically significant differences were noted for each analysis, with statistical significance based on a p value of <0.05.

RESULTS

Preoperative findings

Group I (50-69 years old) consisted of 25 patients (male/female, 15/10) with a mean age of 60.1±4.4 years and group II (≥70 years) consisted of 29 patients (male/female, 19/10) with a mean age of 74.9±3.09 years. Both groups were matched in terms of age (p<0.01),

gender distribution (p=0.675), body mass index (p=0.547), body surface area (p=0.845), hypertension (HT; p=0.430), diabetes mellitus (DM; p=0.212) and smoking habit (p=0.223). The number of patients treated for chronic obstructive pulmonary disease (COPD) was higher in group II (p=0.014).

Functional capacities of patients were evaluated according to New York heart association functional capacity (NHYA). The functional capacity of the patients in both groups was usually class-II (p=0.461). Fatigue, effort dyspnea and angina were the most common symptoms. Five patients had syncope and two patients had congestive heart failure.

Preoperative echocardiography (ECHO) values were recorded. Ejection fraction (EF, p=0.458), left atrial diameter (LAD; p=0.611), left ventricular end-systolic diameter (LVESd, p=0.659), left ventricular end-diastolic diameter (LVEDd, p=0.344), interventricular septum thickness (p=0.821) and valve area (p=0.951) did not show any significant difference between the two groups. Although the maximal gradient values of the patients in group II were higher, there was no difference between the two groups (70.16±14.4 versus 76.45±16.8, p=0.162, respectively). None of the patients had coronary artery disease (CAD), aortic aneurysm and other disease such as mitral valve disease and carotid artery (Table 1).

According to preoperative laboratory values; preoperative hemoglobin levels were lower in group II patients than in group I (14.4±0.76 versus 13.1±1.03, p<0.01, respectively) and creatinine levels in group II were higher (0.97±0.18 versus 1.23±0.26, p<0.01, respectively). The preoperative demographic and clinical findings of the patients are shown in Table 1. Three (12%) patients in

group I and four (13.7%) patients in group II were on medication for hypothyroidism. The risk scores of the patients were calculated with euroscore and the risk scores of group II patients were higher (p<0.01).

Operative findings

Mechanical aortic valve replacement (St Jude Medical; St Paul, Minn.) was performed for all patients. The mean mechanical valve diameters were 20.2±1.13 mm in group I and 20.03±1.26 mm in group II (p=0.364). There was no significant difference between the two groups in terms of ACC (49.92±9.09 versus 56.66±8.71 minutes; p=0.08, respectively), whereas duration of CPB was significantly longer in group II (79.7±9.2 versus 94.4±10.9; p<0.01, respectively). Epicardial pace-maker was performed for all patients after CPB.

Postoperative findings

The hospital mortality rate (for the first 30 days) was 9.2% (5/54) and there was no significant difference between the two groups (p=0.358). In group I, one patient died due to low cardiac output syndrome, and four patients in group II died due to low cardiac output syndrome, pulmonary failure, acute renal failure and cerebrovascular event. The mortality rate of the patients follow-up the first six months was 8.1% (4/49) and no difference was found between the two groups (p=0.153). Type 1 aortic dissection developed on the 68th day in a patient in group I, while one patient died due to sepsis, one patient with cerebral hemorrhage due to warfarin overdose, and one patient with gastrointestinal hemorrhage in group II.

Early postoperative findings are listed in Table 3 and early postoperative complications are listed in Table 4.

Table 1: Demographic characteristics of the studied population.

Variable	Group I (n=25)	Group II (≥70 age) (n=29)	P value
Average age (years)	60.1±4.4	74.9±3.09	<0.01
Male patients n (%)	15 (60)	19 (65.5)	0.675
BSA, m²	1.84±0.17	1.85±0.16	0.845
BMI, kg/m²	25±2.2	24.3±2.3	0.547
HT (n%)	14 (56)	18 (62)	0.430
DM (n%)	11 (44)	17 (58.6)	0.212
COPD (n%)	8 (32)	19 (65.5)	0.014
Smoking habits (%)	13 (52)	11 (38)	0.223
Preoperative ECHO data			
EF (%)	56.88±7.2	55.17±8.5	0.458
Max. gradient	70.16±14.4	76.45±16.8	0.162
Left atrial diameter (mm)	40.16±3.5	39.62±4.1	0.611
LVESd (cm)	35.88±3.08	36.31±3.9	0.659
LVEDd (cm)	51.76±4.5	50.48±5.1	0.344
IVS thickness (cm)	1.44±0.8	1.43±0.98	0.821
Valve area, cm²	1.05±0,03	1.07±0,05	0.951

Continued.

Variable	Group I (n=25)	Group II (≥70 age) (n=29)	P value
NHYA			
Class I	3 (12)	0	N
Class II	21 (80.4)	24 (82.7)	0.461
Class III	1 (4)	5 (17.2)	N
Class IV	0	0	N
EuroScore	0.89±0.39	1.62±0.72	<0.01
Haemoglobin, gr/dl	14.4±0.76	13.1±1.03	<0.01
Creatinine, mg/dl	0.97±0.18	1.23±0.26	<0.01
HbA1c, %	5.92±0.36	6.88±1.2	0.312

HT: hypertension; DM: diabetes mellitus; BSA: body surface area; BMI: body mass index; EF: ejection fraction; LVESd: left ventricular end-systolic diameter; LVEDd: left ventricular end-diastolic diameter; IVS: interventricular septum; NHYA: New York Heart Association functional capacity; COPD: chronic obstructive pulmonary disease

Table 2: Operative findings.

Variable	Group I (n=25)	Group II (n=29)	P value
Mechanical valve diameter, mm	20.2±1.13	20.03±1.26	0.364
Duration of CPB, min	79.7±9.2	94.4±10.9	<0.01
Duration of ACC, min	49.92±9.09	56.66±8.71	0.08

CPB: cardiopulmonary bypass; ACC: aortic cross-clamp

Table 3: Early postoperative findings.

Variable	Group I (n=25)	Group II (n=29)	P value
MV (h)	6.92±1.7	12.9±8.8	<0.01
Drainage (cc)	740±173	865.5±151.8	0.07
ES (unit)	0.84±0.6	1.46±0.7	0.03
Haemoglobin, gr/dl	11.3±1.25	9.78±2.1	0.04
Creatinine, mg/dl	1.03±0.78	1.58±1.1	<0.01
IABP	2	5	0.313
ICU (day)	2.76±2	4.79±3.2	<0.01
DHS (day)	9.32±1.4	12.4±1.5	0.01

MV: duration of mechanical ventilation; ES: erythrocyte suspension; IABP: intraaortic balloon pump support; ICU: duration of ICU stay, DHS: duration of hospital stay

Table 4: Early postoperative complications.

Variable	Group I (n=25)	Group II (n=29)	P value
Revision due to bleeding	3	6	0.393
ARF	3	11	0.03
Dialysis	0	8	<0.01
AF, n (%)	4 (16)	12 (41.3)	0.04
SVE	1	6	0.06
Sternum infection	3	5	0.589
Mediastinitis	1	2	0.643
Pneumonia	2	9	0.03
Pleural fluid	5	15	0.01
Sternum revision	1	5	0.123
Mortality			
First month (5/54)	1	4	0.358
Sixth month (4/49)	1	3	0.153

ARF: acute renal failure; AF: atrial fibrillation; SVE: cerebrovascular event

The duration of mechanical ventilation (p<0.01), duration of intensive care unit stay (p<0.01) and duration of hospitalization (p=0.01) were longer in group II patients. In the first 30 days, atrial fibrillation occurred in 16 (29.6%) of 54 patients and 12 of them were in Group II (p=0.04). Patients who were developed AF had mechanical ventilator durations longer than 12 hours, five had cerebrovascular events and four had acute renal failure. When logistic regression analysis was performed, it was found that new-onset AF was associated with advanced age, hypertension, duration of CPB, duration of ACC, postoperative anemia, cerebrovascular event and high creatinine values (Table 5). Sinus rhythm was achieved in 11 patients with antiarrhythmic treatment and cardioversion. Permanent pacemaker implantation due to atrioventicular block was performed for three patients in group II (10.3%, 3/29).

Although the amount of 24-hour drainage was higher in group II, no significant difference was found (p=0.07) but in group II, more blood transfusions (red blood cell; RBC) were used (p=0.03). Nine patients (6 patients in group II) underwent revision due to bleeding. Six of the seven

patients (7/54, 12.9%) who developed cerebrovascular events were in group II (p=0.06). Three of these patients had transient hemiparesis. Eight patients had sternal infection (three patients group I, five patients in group II) and three patients had mediastinitis (one patient in group I and two patients in group II). These patients had diabetic patients with HbA1c levels above 7%. Acute renal failure (ARF) was developed in 11 patients in group II and dialysis was performed in eight of these patients. These patients had preoperative creatinine values >1.2. Three patients who were developed ARF in group I, did not require dialysis.

All patients were checked with ECHO at first month follow-up. The mean gradient was 15.2±1.3 mmHg in group I and 16.4±0.92 mmHg in group II (p=0.216). New-onset AF was not detected at the first and sixth month follow-up controls. Warfarin dose was 5.5±1.7 mg for group I and 5.7±2.4 mg for group II (p=0.639).

Table 5: Variables associated with AF.

Variables	P value
Advanced age	0.02
HT	0.04
COPD	0.07
DM	0.675
EuroScore	0.207
CPB duration, minute	0.03
ACC duration, minute	<0.01
Mechanical valve diameter	0.374
Postoperative anemia	0.04
High creatinine value	<0.01
SVE	<0.01
MV	0.263
ICU	0.107
DHS	0.108

HT: hypertension; COPD: chronic obstructive pulmonary disease; DM: diabetes mellitus, CPB: cardiopulmonary bypass; ACC: aortik kross-klemp; SVE: serebrovascular event; MV: duration of mechanical ventilation; ICU: duration of ICU stay; DHS: duration of hospital stay

DISCUSSION

The increase in the number of elderly population in societies where life expectancy increases, causes aortic valve diseases more frequently. This means an increase in the number of elderly patients with aortic valve disease.evaluated for operation.[2] The widespread use of non-invasive diagnostic methods, in particular, contributes to this increase.[8] Although these patients are in the older age group, the age factor alone does not constitute a contraindication to surgery.[9] In the literature, it is stated that aortic valve surgery can be performed with acceptable mortality and morbidity rates in elderly patients thanks to satisfactory long-term results.[10,11]

In our study, the data of 29 patients aged 70 years and over (min-max: 70-86) who underwent isolated aortic valve replacement due to aortic stenosis were compared with the data of 25 younger patients (min-max: 50-69) who underwent isolated aortic valve surgery. The mortality rate in the old patient group (group II) was found 13.7% (4/29) for the first 30 days. Low cardiac output syndrome, pulmonary insufficiency, acute renal failure and cerebrovascular event were the causes of mortality. These causes of mortality were similar to mortality reasons which Langanay's et al pointed out their study.[12] In addition, two patients died at the 6th month follow-up due to haemorrhage. This situation was thought to be due to the use of warfarin and mechanical valve application because of inability to provide a bioprosthetic valve for various reasons such as economic.

Postoperative complications after aortic valve surgery increase mortality and morbidity rates, and more than half of elderly patients have postoperative complications.[1,2] The cumulative complication rate in our young patients (group I) was 20%, while this rate was 62% in the elderly patient group (p<0.01; Table 4). While pleural fluid and AF were predominant in young patients, pleural fluid, pneumonia, acute renal failure and AF ratio were high in the elderly patient group.

AF continues still to be the most common form of arrhythmia after open heart surgery, and pave the way for postoperative complications such as stroke, low cardiac output syndrome. In addition, it increases hospital mortality, prolongs the duration of intensive care and hospital stay and causes cardiac dysfunction in the late postoperative period.[13-15] In a study by Banach et al reported that AF developed nearly half the percentage of 150 patients with aortic stenosis who were operated and new-onset AF was associated with advanced age, poor ejection fraction, high gradient levels and interventricular septum thickness.[16] In the same study, low cardiac output syndrome, stroke and mortality rates were found significant in patients with AF.[16] In a study by Gilmanov et al patients who underwent classical sternotomy were compared with patients who had minimally invasive procedures. Atrial fibrillation and blood transfusion decreased significantly in patients who underwent minimally invasive surgery.[17] Filardo et al reported that postoperative new-onset AF was 37% and was more common in elderly patients.[18] Júnior et al. found that new-onset AF rate was 32.8% in 348 patients aged 70 years and over, the and AF was more frequent in patients over 80 years of age.[19] In our study, postoperative new-onset AF was higher in older patients (41.3%) than in younger patients. In addition, with logistic regression analysis, we significantly found to new-onset AF assossiated with advanced age (p=0.02), hypertension (p=0.04), duration of CPB (p=0.03), duration of ACC (p<0.01), postoperative anemia (p=0.04), cerebrovascular events (p<0.01) and high creatinine values (p<0.01) (Table 5). The fact that four patients with AF in group II died due to low cardiac output syndrome and cerebrovascular events, make think

AF is associated with mortality. The factors affecting AF development and the effect of AF on the mortality rate, the length of intensive care and length of hospital stay are similar to the literatüre.[16,19-21]

Limitations

All factors that play a role in the etiology of atrial fibrillation were not interpreted in the study. Larger series are needed with study groups where other major risk factors are similar. In such a study, prospective analysis of postoperative arrhythmias would be beneficial.

CONCLUSION

This study showed that isolated aortic valve replacement could be performed with acceptable risks in advanced age patients and AF risk factors should be determined preoperatively. Sustaining CPB with moderate hypothermia and high mean arterial pressures without prolong duration of CPB and ACC may reduce the AF rate. Considering the bad clinical condition caused by AF, it is better to understand how closely electrocardiographic monitoring is important. Correction of aortic valve stenosis by operation prolongs life expectancy and increases functional capacity than patients who are not operated. Accordingly, we think that aortic valve replacement should be performed at any age under acceptable risk.

The fact that AF has multifactorial etiology makes it difficult to evaluate all risk factors. The most important factors limiting our study are the low number of patients and the lack of long-term results. However, we believe that present study is an informative study in terms of to determine the factors affecting new-onset AF with preoperative risk analysis.

REFERENCES

1. Collart F, Feier H, Kerbaul F, Mouly-Bandini A, Riberi A, Mesana TG, et al. Valvular surgery in octogenarians: operative risks factors, evaluation of Euroscore and long term results. Eur J Cardio-thoracic Surg. 2005;27:276-80.
2. Kolh P, Kerzmann A, Honore C, Comte L, Limet R. Aortic valve surgery in octogenarians: predictive factors for operative and long-term results. Eur J Cardio-thoracic Surg. 2007;31:600-6.
3. Khan MF, Wendel CS, Movahed MR. Prevention of Post–Coronary Artery Bypass Grafting (CABG) Atrial Fibrillation: Efficacy of Prophylactic Beta-Blockers in the Modern Era A meta-analysis of latest randomized controlled trials. Ann Noninvasive Electrocardiol. 2013;18:58-68.
4. Banach M, Okon´ski P, Rysz J, Piechowiak M, Zasłonka J. Prevention and treatment of atrial fibrillation following cardiac surgery. Pol Merkur Lekarski. 2005;19:794-9.
5. Kohno H, Ueda H, Matsuura K, Tamura Y, Watanabe M, Matsumiya G. Long-term consequences of atrial fibrillation after aortic valve replacement. Asian Cardiovasc Thoracic Ann. 2017;1-13.
6. Dumani S, Likaj E, Kacani A, Dibra L, Petrela E, Beca V, Refatllari A. Incidence and Impact of Patient-Prosthesis Mismatch in Isolated Aortic Valve Surgery. Open Access Maced J Med. 2015;3(4):624-9.
7. Hernández-Vaquero D, Llosa JC, Díaz R, Khalpey Z, Morales C, López RAJ, Boye F. Impact of patient-prosthesis mismatch on 30-day outcomes in young and middle-aged patients undergoing aortic valve replacement. J Cardiothoracic Surg. 2012;7:46.
8. Roger V, Tajik A, Reeder G, Hayes S, Mullany C, Bailey K, et al. Effect of Doppler echocardiography on utilization of hemodynamic cardiac catheterization in the preoperative evaluation of aortic stenosis. Mayo Clin Proc. 1996;71;141-9.
9. Ekim H, Kutay V, Tuncer M, Mustafaoğlu F, Yakut C. Aort Darlığı Olan Hastalarda Aort Kapak Replasmanının Klinik Sonuçları. Van Tıp Dergisi. 2005;12:(4):228-31.
10. Sundt TM, Bailey MS, Moon MR, Mendeloff EN, Huddleston CB, Pasque MK, et al. Quality of Life After Aortic Valve Replacement at the Age of >80 Years. Circulation. 2000;102:70-4.
11. Chiappini B, Camurri N, Loforte A, Di Marco L, Di Bartolomeo R, Marinelli G. Outcome after aortic valve replacement in octogenarians. Ann Thorac Surg. 2004;78(1):85-9.
12. Langanay T, Flécher E, Fouquet O, Ruggieri VG, Tour BD, Félix C, et al. Aortic Valve Replacement in the Elderly: The Real Life. Ann Thorac Surg. 2012;93:70-8.
13. Banach M, Mariscalco G, Ugurlucan M, Mikhailidis PT, Barylski M, Rysz J. The significance of preoperative atrial fibrillation in patients undergoing cardiac surgery: preoperative atrial fibrillation—still underestimated opponent. Europace. 2008;10:1266-70.
14. Kuduvalli M, Grayson AD, Au J, Grotte G, Bridgewater B, Fabri BM, et al. A multi-centre additive and logistic risk model for in-hospital mortality following aortic valve replacement. Eur J Cardio-thoracic Surg. 2007;31:607-13.
15. Ngaage DL, Schaff HV, Barnes SA, Sundt TM III, Mullany CJ, Dearani JA, et al. Prognostic implications of preoperative atrial fibrillation in patients undergoing aortic valve replacement: is there an argument for concomitant arrhythmia surgery? Ann Thorac Surg. 2006;82:1392-9.
16. Banach M, Goch A, Misztal M, Rysz J, Jaszewski R, Goch JH. Predictors of paroxysmal atrial fibrillation in patients undergoing aortic valve replacement. J Thorac Cardiovasc Surg. 2007;134:1569-76.

17. Gilmanov D, Bevilacqua S, Murzi M, Cerillo AG, Gasbarri T, Kallushi E, Miceli A, Glauber M. Ann Thoracic Surg. 2013;96(3):837-43.
18. Filardo G, Hamilton C, Hamman B, Hebeler RF, Adams J, Grayburn P. New-Onset Postoperative Atrial Fibrillation and Long-Term Survival after Aortic Valve Replacement Surgery. Ann Thorac Surg. 2010;90:474-80.
19. Júnior FP, Filho GFT, Sant'anna JRM, Mondim Py M, Prates PR, Nesralla IA, et al. Advanced age and incidence of atrial fibrillation in the postoperative period of aortic valve replacement. Rev Bras Cir Cardiovasc. 2014;29(1):45-50.
20. Orlowska-Baranowska E, Baranowski R, Michalek P, Hoffman P, Rywik T, Rawczylska-Englert I. Prediction of paroxysmal atrial fibrillation after aortic valve replacement in patients with aortic stenosis: Identification of potential risk factors. J Heart Valve Dis. 2003;12:136-41.
21. Mistiaen W, Van Cauwelaert P, Muylaert P, Wuyts F, Harrisson F, Bortier H. Risk factors and survival after aortic valve replacement in octogenarians. J Heart Valve Dis. 2004;13:538-44.