Albanian Journal of Trauma and Emergency Surgery (2025) 9/2:1802 - 1807
DOI: 10.32391/ajtes.v9i2.462

ORIGINAL ARTICLES

Isolated Aortic Valve Replacement: Early Results from a 16-Year Experience

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Received: 24 April 2025 / *Accepted:* 15 May 2025 / *Published online:* 20 July 2025
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Abstract

Background: Aortic valve replacement (AVR) has been a routine procedure since the introduction of heart valve prostheses in the late 1960s and early 1970s. It is the most commonly performed heart valve surgery in cardiac surgical practice.

This study aims to present the early postoperative outcomes of isolated AVR surgery performed at the Service of Cardiac Surgery, University Hospital Center "Mother Teresa," Tirana, Albania, from January 2007 to December 2023.

Materials and Methods: Patients who underwent isolated aortic valve surgery were included in this retrospective study. All surgeries were performed at the Service of Cardiac Surgery, University Hospital Center 'Mother Teresa,' Tirana, Albania, from January 2007 to December 2023.

Results: The study included 491 patients (311 males and 180 females) with a mean age of 62.28 ± 10.76 years. The majority of patients (72.5%) had aortic valve stenosis. At hospital admission, most patients were classified as New York Heart Association (NYHA) Class III (54.2%) or Class II (38.9%). In-hospital mortality was 1.6% (8/491 patients). The most frequent postoperative complications included new-onset atrial fibrillation (15.5%), conduction disorders requiring permanent pacemaker implantation (6.5%), and low cardiac output syndrome (3.7%). Cardiopulmonary bypass time, aortic cross-clamp time, respiratory Assistance time, intensive care unit stay, and postoperative hospital stay were 83.85 ± 22.63 minutes, 65.22 ± 19.20 minutes, 16.2 ± 42.16 hours, 59.59 ± 65.60 hours, and 9.15 ± 4.45 days, respectively.

Conclusion: The early results of aortic valve surgery at our center are satisfactory and significant. With a low mortality rate and a relatively low incidence of postoperative complications, our outcomes align with international standards, underscoring the safety and effectiveness of AVR in our institution. These findings contribute to the growing body of knowledge in cardiac surgery, providing valuable insights for future research and practice.

Keywords: aortic valve replacement, aortic valve surgery, heart valve surgery, early mortality

Introduction

Isolated aortic Valve Replacement (AVR) is the most common valvular heart disease in developed countries, and its prevalence is expected to increase due to the aging population in industrialized nations.[1] This study focuses on the early postoperative outcomes of isolated AVR surgery, a routine procedure since the introduction of valve prostheses in the late 1960s and early 1970s. The surgical procedure has remained the same despite developing of various prostheses and numerous procedural improvements. [2]

Original article, no submission or publication in advance or in parallel

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In our country, valvular heart surgery began with a closed commissurotomy of the mitral valve, while prosthetic valve replacements started in the early 1980s. In aortic valve surgery, initial treatments focused on aortic valvular disease of rheumatic origin; however, the profile has since shifted entirely toward degenerative pathology of the aortic valve. AVR is our clinic's most frequently performed heart valve surgery.

Our study aims to present the early postoperative outcomes of isolated AVR surgery performed at the Service of Cardiac Surgery, University Hospital Center "Mother Teresa," Tirana, Albania, from January 2007 to December 2023. This is the first comprehensive analysis encompassing such an extensive dataset, providing an in-depth review of the current state and evolving trends in the surgical treatment of aortic valve diseases in our country. Additionally, the study compares our center's results with those of other cardiac surgery clinics.

Materials and Methods

This study is a retrospective analysis conducted at the Service of Cardiac Surgery, University Hospital Center "Mother Theresa," Tirana, Albania, from January 2007 to December 2023. The study included patients who underwent isolated AVR.

The exclusion criteria included additional surgeries except for AVR, aortic valve endocarditis, and reoperations. Patient data were collected from hospital medical records and operating room registers.

The collected data included general demographic information, clinical status on admission according to the New York Heart Association (NYHA) classification, comorbidities, type of aortic valve pathology, operating times (cross-clamping time and cardiopulmonary bypass time), postoperative times (intensive unit care stay, respiratory assistance under mechanical ventilation, and postoperative hospital stay), early postoperative mortality, and significant postoperative complications, such as stroke, conduction disorders, arrhythmias, infections, respiratory disorders, and revisions due to hemorrhage.

The collected data were presented as mean values, standard deviations, and percentages. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 26.0. The study's primary endpoints were early mortality, major postoperative complications, and intraoperative times. Early mortality was defined as in-hospital postoperative mortality.

Results

The study included 491 patients who underwent isolated AVR from January 2007 to December 2023. Table 1 outlines the patients' demographic characteristics, clinical conditions at the time of hospital admission, valve pathologies, and comorbidities. The majority of the group was male, comprising 63.34% (311/491 patients), while 36.66% (180/491 patients) were female.

The mean age of the patient group was 62.28 ± 10.76 years. Most patients (91.2%) underwent elective surgery, while 8.8% required urgent interventions. Upon hospital admission, the majority of patients were classified as NYHA Class III (54.2%) or Class II (39.9%), reflecting moderate to severe heart failure symptoms. A smaller percentage were in Class I (2.65%) or Class IV (4.25%).

The most common aortic valve pathology observed was aortic valve stenosis (72.5%), followed by aortic valve regurgitation (14.6%) and mixed pathology (12.9%). The most prevalent comorbidity was arterial hypertension (71.6%), followed by diabetes mellitus (17.4%) and chronic obstructive pulmonary disease (COPD) (3.7%). Smokers accounted for 15.7% of the patients. Renal disease and obesity were observed in 2.5% of the patients.

Data	Number of Patients	Mean ± SD or (%)
Age (years)	491	62.28 ± 10.76
Male	311	63.34
Female	180	36.66
Elective	447	91.00
Urgent	44	9.00
NYHA Class I	13	2.65
NYHA Class II	191	38.90
NYHA Class III	266	54.20
NYHA Class IV	21	4.25
Aortic Valve Stenosis	356	72.5
Aortic Valve Regurgitation	72	14.6
Mixed	63	12.9
Arterial Hypertension	350	71.6
Diabetes Mellitus	85	17.4
Smoking	77	15.7
Kidney Disease	12	2.5
COPD	18	3.7

SD -Standard Deviation, NYHA-New York Heart Association, COPD-Chronic Obstructive Pulmonary Disease; Mixed-Aortic Valve Stenosis + Aortic Valve Regurgitation

Table 1: General Data and Comorbidities

Table 2 summarizes the echocardiographic data, which was the primary diagnostic tool used. The findings indicate the presence of left ventricular hypertrophy, although left ventricular function was preserved. The average size of the aortic valve annulus was 21.62 ± 1.92 mm.

Table 3 outlines key intraoperative and postoperative times. The average cardiopulmonary bypass (CPB) duration was 83.85 ± 22.63 minutes, while the mean aortic cross-clamp time (XC) was 65.22 ± 19.20 minutes. It is well-known that operative times, such as the duration of cardiac

Data	Mean ±SD
EF (%)	60.10 ± 9.18
PsAP(mmHg)	40.49 ± 15.37
Aortic annulus size (mm)	21.62 ± 1.92
ThPW (mm)	14.18 ± 9.83
Th Sept (mm)	15.27 ± 8.32
TDD (mm)	55.38 ± 9.96
TSD (mm)	38.68 ± 8.70
Mean gradient (mmHg)	52.90 ± 14.16
SD - Standard Deviation, PsAP - Pulmonary Artery Systolic Pressure, ThPW - Thickness Posterior Wall, ThS - Thickness of the Septum, TDD - Tele Diastolic Diameter; TSD - Tele Systolic Diameter; Max Grad-Maximal Transaortic Valve Gradient; Mean Grad - Mean Transaortic Valve Gradient	

Table 2: Echocardiography Data

arrest (cross-clamp time) and extracorporeal circulation (cardiopulmonary bypass), are crucial factors affecting surgical outcomes. Postoperative times are as follows: the average ICU stay was 59.59 ± 65.60 hours; the mean duration of mechanical respiratory assistance was 16.12 ± 42.16 hours; and the average postoperative hospital stay was 9.15 ± 4.45 days.

Data	Mean ± SD
CPB (min)	83.85 ± 22.63
XC (min)	65.22 ± 19.20
ICU Stay (hours)	59.59 ± 65.60
Postoperative Hospital Stay (days)	9.15 ± 4.45
Mechanical Respiratory Assistance Time (hours)	16.12 ± 42.16
SD-Standard Deviation, Min-minutes, CPB- Cardiopulmonary Bypass, XC - Aortic Cross-Clamp, ICU-Intensive Care Unit	

Table 3: Intraoperative and postoperative times

Table 4 shows the hospital mortality rate and the major postoperative complications.

The hospital mortality rate was 1.6% (8/491 patients). Low cardiac output following the procedure was observed in 3.7% (18/491 patients), while strokes were rare, affecting just 1.0% (5/491 patients). Postoperative bleeding was observed in 1.2% (6/491 patients), and atrial fibrillation (AF) emerged as the most frequent postoperative complication, affecting 15.5% (76/491 patients). Wound infections were observed in 1.6% (8/491 patients), and the rate of conduction disorders requiring implantation of a permanent pacemaker was 6.5% (32/491 patients.

Complications	No. of patients	Percentage
Hospital Mortality	8	1.6
Low Cardiac Output	18	3.7
Stroke	5	1.0
Renal insufficiency	1	0.2
Revision for bleeding	6	1.2
New Onset Atrial Fibrillation	76	15.5
Wound Infection	8	1.6
Conduction disorders	32	6.5

Table 4. Early Postoperative Complications

Discussion

Our study included 491 patients who underwent isolated AVR over 16 years. *Chan et al.* [3] from the Bristol Heart Institute in the United Kingdom published one of the most extensive studies in the literature, involving 79,173 patients over 22 years, examining both early and late mortality. *Celik et al.* [4] from Erasmus Medical Center in the Netherlands reviewed 4,404 patients over 29 years, while Johnston et al. [5] also published an extensive series of 3,493 patients. Our patient series is comparable to most studies published in the literature. *Kaneko et al.* [6] reviewed 683 patients, *Winkler et al*. [7] analyzed 688 patients, and *Lee et al.* [8] analyzed 362 patients.

In our study, 63.34% of the patients were male, which aligns with the most extensive studies mentioned above [3, 4, 5], which reported a predominance of males over females in isolated aortic valve surgery, with percentages ranging from 59% to 65%. The average age of patients who underwent isolated aortic intervention was relatively young, 62.28 ± 10.76 years, compared to some of the studies [3, 4, 5, 6].

Chan et al. [3] demonstrated that the average age in their study was 67.99 ± 12.48 years, while *Johnston et al.* [5] reported the average age as 64 ± 13 years.

The urgency of the intervention is a factor that negatively affects early operative results. In our population, only 9% of patients underwent urgent intervention, while the urgent aortic valve surgery rate reported in the current literature varies from 1.6% to 19% [3, 6, 7, 8].

The preoperative heart failure stage is a factor that should be emphasized because its presence can negatively impact postoperative outcomes [9]. In our study, 41.5% of patients presented in NYHA I and II, while 58.45% presented in NYHA III and IV.

These data indicate that many of our patients undergo the intervention at an advanced stage of the disease, thereby increasing the operative risk. The profile in other cardiac surgery centers is similar to, or better than, that of our clinic.

We considered NYHA III and IV stages in our analysis. The prevalence of patients presenting in these stages varies from 16% to 41% [5, 6, 7].

Additionally, the profile of comorbidities in patients requiring AVR is significant. In our study, arterial hypertension was the most common comorbidity, found in 71.6% of patients, followed by diabetes mellitus, which was found in 17.4%.

Thilen et al. published one of the most important studies in the literature regarding the significance of preoperative comorbidities on postoperative outcomes in isolated aortic valve surgery. They reported that arterial hypertension was present in 40.5% of patients [10]. Diabetes mellitus in this group of patients varies from 8% to 26% [6, 7, 8].

The dominant pathology of the aortic valve in patients referred for surgery was aortic valve stenosis, encountered in 72.5% of patients. Aortic valve regurgitation and mixed pathology of the aortic valve were encountered in 14.6% and 12.9% of the group, respectively.

Chan et al. reported that severe aortic stenosis with an indication for intervention affected 66.8% of patients, followed by mixed pathology in 18.3% and aortic regurgitation in 14.9% [3].

Similarly, other studies reported that the predominant pathology of the aortic valve requiring surgery was aortic valve stenosis. The reported incidence of aortic stenosis as the primary pathology ranges from 66% to 80% [4, 5].

Operative times are an important factor related to postoperative outcomes. It is reported that prolonged aortic cross-clamp time is an independent predictor of mortality and hospital morbidity. Longer cross-clamp times, although within acceptable limits, have been independently associated with decreased late survival following isolated aortic valve surgery [10, 11].

These studies once again highlight the importance of CPB and cross-clamp time. In our study, the CPB time was 83.85 ± 22.63 minutes, while the mean cross-clamp time was 65.22 ± 19.20 minutes. These values are considered very satisfactory compared to those reported in other studies. *Lino et al.* [12], in a study of 16,272 patients, reported longer operative times: 137 ± 48 minutes for CPB and 96 ± 33 minutes for cross-clamp time. *Swinkels et al.* [11], who exclusively analyzed operative times, reported a mean extracorporeal circulation time of 92.7 ± 42.5 minutes and a mean cross-clamp time of 64.2 ± 16.1 minutes.

The most common postoperative complication in our study was atrial fibrillation, which occurred in 15.5% of patients. *Kalra et al*. published one of the most extensive studies with 122,765 patients analyzing postoperative atrial fibrillation. They reported a postoperative atrial fibrillation rate of 50.1%, which was directly associated with more extended hospital stays, stroke, and in-hospital mortality [12].

Meanwhile, studies with a population size similar to ours [6, 7, 8] reported that postoperative atrial fibrillation occurred in 25% to 35% of patients.

Stroke, a life-threatening postoperative complication, was also analyzed in our study.

Agarwal et al. [13] published a study with 57,324 patients and found that stroke occurred in 1.7% of patients, while *Hamm et al*. [14], in a study with 6,523 patients, reported a stroke incidence of 1.3%. In our study, stroke occurred in 1% of patients, a very satisfactory figure when compared to the literature.

Low cardiac output is an important postoperative complication during aortic valve surgery that often leads to increased morbidity and mortality.

In a retrospective study analyzing 2,255 patients who underwent isolated aortic valve surgery, the prevalence of low-output syndrome was found to be 3.9%, with independent predictors including renal failure, ejection fraction <40%, cardiogenic shock, female sex, and older age [15].

In our study, low-output syndrome occurred in 3.7% of patients, who were managed with positive inotropic drugs and intra-aortic balloon pumps. Conduction disorders are a significant complication in aortic valve surgery because they are directly related to the anatomical aspects of the valve.

In our study, the incidence of conduction disorders was 6.5%, which included cases requiring permanent pacemaker implantation. *Moskowitz et al.* [16], in a study involving 77,882 patients who underwent cardiac valve interventions, found that the incidence of conduction disorders treated with permanent pacemaker implantation was 9.3%. Comparing our results with this complication shows satisfactory outcomes.

Although the age, frequency of comorbidities, and overall complexity of patients undergoing isolated aortic valve surgery have increased over the years, mortality has not shown a corresponding rise [3, 4, 5]. *Lee et al.* conducted a comprehensive study over 14 years, analyzing 623,039 valve procedures to evaluate national trends in valve intervention outcomes. This group reported a hospital mortality rate of 4.9% [17].

According to *Kirklin* [18], hospital mortality for isolated aortic valve replacement is approximately 3.5%, while *Astor et al.* [19], in a study involving 46,397 patients, reported early mortality at 4.3%.

Chan et al. [3] reported a significant reduction in mortality in recent years, with a current rate of 1.06%. In our study, mortality was 1.6%, which is a very satisfactory outcome compared to the above studies.

Meanwhile, studies with a population size similar to ours [6, 7, 8] reported hospital mortality rates ranging from 1.6% to 7.1%, further highlighting the strong performance of our surgical team and their steadily increasing experience.

Conclusion

The clinical profile of patients undergoing isolated AVR in our clinic is similar to that observed in other cardiac surgery centers. Aortic valve stenosis is the predominant pathology, and male patients are more frequently affected by aortic valve disease. Advanced stages of the disease at the time of intervention are commonly observed. The early results regarding in-hospital mortality, major postoperative complications, and operative times demonstrate that AVR

can be performed with very satisfactory outcomes in our clinic. These outcomes are consistent with international standards, highlighting the safety and effectiveness of AVR at our institution.

COI Statement: This paper has yet to be submitted in parallel, presented fully or partially at a meeting, podium, or congress, published, or submitted for consideration beforehand.

This research received no specific funding from public, commercial, or non-profit sectors. The authors declare that they, their relatives, or next of kin have no financial relationships with external companies that could be considered relevant or minor.

Disclosure: The authors declared no conflict of interest. No funding was received for this study.

Abbreviation

AVR - Aortic Valve Replacement; SD - Standard Deviation; NYHA-New York Heart Association; COPD - Chronic Obstructive Pulmonary Disease; Mixed - Aortic Valve Stenosis + Aortic Valve Regurgitation; PsAP - Pulmonary Artery Systolic Pressure; ThPW - Thickness Posterior Wall; ThS-Thickness of the Septum; TDD - Tele Diastolic Diameter, TSD - Tele Systolic Diameter; Max Grad - Maximal Transaortic Valve Gradient, Min-minutes, CPB - Cardiopulmonary Bypass; XC - Aortic Cross-Clamp, ICU - Intensive Care Unit; AF - Atrial Fibrillation;

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