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Simultaneous Aortic and Mitral Valve Surgery Early Results: A 16-Year Single-Center Experience, a Unique Insight into Long-Term Outcomes

Selman Dumani[1*], Ermal Likaj[1], Laureta Dibra[1], Devis Pellumbi[1], Saimir Kuci[1], Ervin Bejko[1], Edlira Rruci[1], Esmerilda Bulku[1], Alessia Mehmeti[1], Klodian Krakulli[1], Vera Beca[2], Aferdita Veseli[1], Andi Kacani[1], Edvin Prifti[1], Ali Refatllari[1], Elizana Zaimi (Petrela)[3], Alban Dibra[4], Altin Veshti[1]

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Abstract

Introduction: The Euro Heart Survey on Valvular Heart Disease reports that approximately 17% of patients with valvular heart disease are affected by two or more valves simultaneously. The most common combination requiring simultaneous surgery is aortic and mitral valve surgery. This procedure remains highly demanding for all surgical teams, even today.
The primary focus of this study is to present, for the first time, the early postoperative results of simultaneous aortic and mitral valve surgery at our clinic. We aim to compare our outcomes with those reported by other cardiovascular surgical centers, with a strong emphasis on patient well-being and survival rates.
Materials and Methods*:* This is a retrospective study that included adult patients who underwent simultaneous aortic and mitral valve surgery between January 2007 and December 2023 at the Cardiac Surgery Service, UHC "Mother Theresa", Tirana, Albania. The Data collection was performed using operating room registers and hospital medical records. Demographic, clinical, and non-clinical data were gathered for each patient before, during, and after the surgery.
Results: This study included 121 patients, comprising 55 males (45.5%) and 66 females (55.5%). The average age of the study population was 56.41 ± 10.35 years. Most patients underwent elective surgery (111, 91.7%), while 10 (8.3%) were urgent surgical cases. Aortic valve regurgitation was the most prevalent pathology, affecting 58 patients (47.9%). The hospital mortality rate was 6.6% (8 patients). The most common postoperative complications included low cardiac output (17.4%), conduction disturbances requiring permanent pacemaker implantation (8.3%), new-onset atrial fibrillation (8.3%), and postoperative hemorrhage (5.8%).
Conclusions: Our study on simultaneous aortic and mitral valve surgery at our clinic has shown satisfactory early outcomes regarding early mortality and major postoperative complications. These findings offer valuable insights for the medical community and contribute to the ongoing discourse on cardiac surgery outcomes.
Keywords: Simultaneous aortic-mitral surgery, Early results heart valve surgery, Aortic valve surgery, Mitral valve surgery, Aortic valve replacement

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* ***Corresponding author:***
Asc. Prof. Selman Dumani, MD, PhD
✉ *selmandumani@yahoo.co.uk*

1 Cardiac Surgery Service, University Hospital Center "Mother Theresa," Tirana, ALBANIA
2 Service of Hospital Infections, University Hospital Obstetrics and Gynecology "Queen Geraldine," Tirana, ALBANIA
3 Service of Statistics, University Hospital Center "Mother Theresa" Tirana, ALBANIA
4 Service of Cardiology, University Hospital Center "Mother Theresa" Tirana, ALBANIA

Introduction

Multivalvular heart disease is a complex condition that leads to significant mortality and morbidity among patients with valvular heart disease. The Euro Heart Survey on Valvular Heart Disease reports that approximately 17% of patients requiring heart valve surgery have more than one damaged valve [1].

The Society of Thoracic Surgeons Adult Cardiac Surgical Database reports that 11% of patients requiring heart valve surgery undergo simultaneous mitral and aortic valve surgery [2]. Studies involving simultaneous aortic and mitral valve surgery are relatively few compared to those

focusing on isolated valvular surgery.

In cardiothoracic surgery textbooks, hospital mortality is reported to be 9.4% [3], which is high and indicates that simultaneous aortic and mitral valve surgery is a high-risk, complex, and demanding procedure for any surgical team.

This study will present the early outcomes in terms of mortality and postoperative complications of simultaneous aortic and mitral valve surgery at our center over 16 years. We will then compare our results with those from other surgical groups treating this patient cohort.

Materials and Methods:

This is a comprehensive retrospective study that included adult patients who underwent simultaneous aortic and mitral valve surgery between January 2007 and December 2023 at the Cardiac Surgery Service of the UHC "Mother Theresa" in Tirana, Albania.

The Data collection was performed using operating room registers and hospital medical records. Demographic, clinical, and non-clinical data were gathered for each patient before, during, and after the surgery. The surgical procedure was either aortic valve replacement, mitral valve repair, or replacement.

Patients with valve endocarditis, reoperations, and any additional surgical procedures associated with the aortic valve surgery, except mitral valve surgery, were excluded from the study. For each patient, the following information was recorded: general characteristics, admission diagnosis, admission clinical status, associated comorbidities, primary condition leading to hospitalization, operative times (clamp time and extracorporeal circulation time), time spent in the intensive care unit (time of respiratory support with mechanical ventilation and total time in the intensive care unit), in-hospital mortality, and major postoperative complications (stroke, conduction disorders, arrhythmias, infections, respiratory complications, and revision for hemorrhage).

The data are presented as mean values, standard deviation, and percentages. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 26.0 (Released 2019; IBM Corp., Armonk, New York, United States).

Surgical Technique

After the patient is monitored as usual under general anesthesia, a median sternotomy is performed. Once the pericardium is opened, the patient is heparinized, and the aorta is cannulated. Venous drainage is achieved using bicaval cannulation. The left aspiration cannula is placed in the right superior pulmonary vein. Once extracorporeal circulation is initiated, the aorta is clamped.

Cardioplegia is administered from the aortic root and/or directly from the coronary ostia. The cardioplegia used was either crystalloid or a combined solution, with the initial dose being crystalloid, followed by blood cardioplegia. Technically, we followed a procedural sequence as outlined below.

The left atrium was opened, and sutures were placed to secure the mitral valve prosthesis (when mitral valve replacement was performed). Then, aortic valve replacement was carried out. This sequence was followed for two reasons: first, it is technically easier to place the sutures for the mitral prosthesis before the aortic prosthesis is implanted; second, performing mitral valve replacement first may necessitate the use of a smaller prosthesis in the aortic position.

The sutures used to secure the prostheses were 2/0 "U" Ticron sutures with pledgets. In cases of mitral valve repair, the mitral valve repair was performed first, followed by aortic valve replacement. After completing these procedures, the aorta and left atriotomy were closed, the air was removed from the heart, the aorta was unclamped, temporary ventricular epicardial pacemaker leads were placed, drainage tubes were inserted, and the sternum was closed with special steel wires. The wound was then closed in layers.

Results

Table 1 presents a summary of the general characteristics and comorbidities of the patients. This study included 121 patients, of whom 45.5% (55/121) were males and 54.5% (66/121) were females.

Data		No. of patients	% or mean ± SD
Age (years)		121	56.41± 10.35
Gender	Male	55	45.5 %
	Female	66	54.5 %
Intervention	Elective	111	91.7 %
Urgent		10	8.3 %
NYHA	II	24	19.8 %
III		87	71.9 %
IV		10	8.3 %
AVP	AVR	58	47.9 %
AVS		32	26.4 %
AVR+AVS		31	25.6 %
Primary disease	AVP	94	77.6 %
MVP		27	22.4 %
Arterial hypertension		36	29.8%
Diabetes mellitus		11	9.1%
Smoking		11	9.1%
Kidney disease		6	5.0%
COPD		4	3.3%

NYHA - New York Heart Association; AVP- Aortic Valve Pathology; AVR - Aortic Valve Regurgitation; AVS - Aortic Valve Stenosis; MVP- Mitral Valve Pathology; COPD - Chronic Obstructive Pulmonary Disease

Table 1. General Data and Comorbidities

The mean age was 56.41 ± 10.35 years. Most patients, 91.7% (111/121), underwent elective surgery, while 8.3% (10/121) required urgent intervention.

Most patients, 71.9% (87/121), were in NYHA class III at the time of hospitalization. NYHA class II was observed in 19.8% (24/121), while NYHA class IV was noted in 8.3% (10/121).

The most common comorbid condition was arterial hypertension, present in 29.8% (36/121), followed by diabetes mellitus in 9.1% (11/121).

The predominant pathology affecting the aortic valve was aortic regurgitation, found in 47.9% of cases (58/121 patients), followed by aortic stenosis in 26.4% (32/121 patients) and aortic stenosis with insufficiency in 25.6% (31/121 patients). In 27 patients (22%), mitral valve pathology was the primary condition requiring surgical intervention, while aortic valve disease was moderate or moderate-to-severe in these cases.

The echocardiographic data are summarized in Table 2.

Data	Mean	Standard deviation
Ejection Fraction (%)	58.51	8.53
PaSP (mmHg)	47.80	14.05
Aortic Annulus (mm)	21.29	1.72
ThPW (mm)	11.86	1.62
ThS (mm)	12.73	2.33
TDD (mm)	58.49	8.74
TSD (mm)	40.08	8.30
Max Grad (mmHg)	59.44	18.69
Mean Grad (mmHg)	40.40	14.38

PsAP-pulmonary artery systolic pressure, ThPW-thickness of the posterior wall, ThS-thickness of the septum, TDD- telediastolic diameter, TSD- telesystolic diameter, Max Grad-maximal gradient transaortic valve, Mean Grad- mean gradient transaortic valve

Table 2: Echocardiography Data

The mean ejection fraction was 58.51% ± 8.53, while the average diameter of the aortic Annulus was 21.29 ± 1.72 mm. The maximum mean gradient was 59.55 ± 18.69 mmHg, and the average mean gradient was 40.40 ± 14.38 mmHg.

Table 3 shows the intraoperative and postoperative data. The mean extracorporeal circulation time was 121 ± 34.89 minutes, while the mean clamp time was 96.37 ± 24.46 minutes. The mean duration of directed respiratory support was 21.53 ± 39.81 hours. The mean length of stay in the intensive care unit was 63.82 ± 56.91 hours, and the average hospital stay postoperatively was 11.08 ± 6.73 days.

Table 4 presents data regarding the types (mechanical or biological) of aortic valve prostheses used, along with their respective brands and quantities. Mechanical prostheses in the aortic position were used in 90% of cases,

Data	Mean	Standard deviation
CPB time (min)	121.00	34.89
Aortic Cross clamp time (min)	96.37	24.46
Stay in ICU (hours)	63.82	56.91
Hospital stays(days)	11.08	6.73
Respiratory assistance(hours)	21.53	39.81

Table 3. Operative and Postoperative Data

with the most commonly used being the SJM Regent, which was implanted in 58.64% of patients, followed by the St Jude Standard, implanted in 23.9%, and the ATS mechanical aortic prosthesis used in 6.6% of patients.

The biological aortic prosthesis used was the Epic Supra Valve, which was implanted in 13 patients (10%). Regarding the size of the implanted prostheses, the most frequently used size for the aortic position was size 21 in 45.4% of cases, followed by size 19 in 26.4%.

In the procedures performed on the mitral valve, mitral valve replacement was performed in 95 % of patients, while mitral valve repair was performed in 5 %.

Type and No. of prosthesis	No. of patients	Percentage
SJM Standard	29	23,9%
SJM Regent	71	58,64%
SJM Epic Supra	13	10%
ATS mechanical prosthesis	8	6,6%
Prosthesis No 19	32	26,4%
Prosthesis No21	55	45,4%
Prosthesis No22	3	2,4%
Prosthesis No23	20	16,5%
Prosthesis No25	11	9,0%

SJM-Saint Jude Medical, the name of the prosthesis

Table 4: Number and Type of Aortic Valve Prosthesis

Table 5 shows the hospital mortality and major postoperative complications, including low cardiac output,

Postoperative Complications	No. of patients	Percentage
Hospital mortality	8	6.6%
Low cardiac output	21	17.4%
Stroke	1	0.8%
Renal insufficiency	1	0.8%
Revision for bleeding	7	5.8%
New atrial fibrillation	10	8.3%
Wound infection	2	1.7%
Conduction disorders	10	8.3%

Table 5: Hospital Mortality and Major Perioperative Complications

stroke, renal complications, revision for bleeding, new atrial fibrillation, wound infection, and conduction disorders. The hospital mortality rate in this series was 6.6% (8/121).

Low cardiac output, conduction disorders treated with a permanent pacemaker, new atrial fibrillation, revision for bleeding, wound infection, stroke, and renal complications occurred in 17.4% (21/121), 8.3% (10/121), 8.3% (10/121), 5.8% (7/121), 1.7% (2/121), and 0.8% (1/121) respectively.

Discussion

The Society of Thoracic Surgeons Adult Cardiac Surgical Database reports that 11% of all heart valve surgeries involve the simultaneous replacement and/or repair of two or more valves, with the most common combination being the aortic and mitral valves [2].

Multivalvular heart disease is a complex condition that leads to significant morbidity and mortality among patients with valvular heart disease. Surgery provides undeniable benefits in terms of survival and quality of life for these patients. However, despite the extensive Experience gained over several decades, simultaneous multivalvular surgery remains a complex procedure for any surgical team.

We are reporting the early results of simultaneous aortic-mitral valve surgery at our clinic and comparing our Experience with similar studies conducted by other groups on this patient cohort.

Comorbid conditions are present in this population, significantly increasing the operative risk. The most common comorbid conditions in our study group were arterial hypertension, present in 29.8% of cases, and diabetes mellitus, present in 9.1% of cases. Meanwhile, according to the NYHA classification, the clinical status upon hospitalization showed that most patients were in NYHA stage III and IV, accounting for 80% of cases.

This situation is consistent with several studies that reported the prevalence of NYHA stages III and IV ranging from 66% to 88% [4, 5, 6, 7, 8]. The assessment of comorbid conditions and the clinical status of patients holds undeniable value when evaluating surgical risk and implementing measures to improve these conditions.

The goal is to achieve the optimal preoperative condition, with the primary aim of obtaining the best possible surgical outcomes.

In a study involving 813 patients who underwent aortic-mitral surgery, the dominant pathology affecting the aortic valve was combined aortic valve disease in over 50% of cases, followed by aortic valve stenosis in 29%. The remaining instances predominantly involved aortic valve regurgitation [7]. Several other studies report that the predominant pathology was aortic stenosis, with values ranging from 39% to 48% [5, 6, 9].

In our study group, the predominant pathology affecting the aortic valve was aortic valve regurgitation, which occurred in 47.9% of cases, followed by aortic stenosis in 26.4% of cases, and mixed disease (a combination of stenosis and regurgitation) in 25.6%.

In the majority of literature reports, males are more commonly affected by multivalvular heart valve disease. Two extensive studies have indicated that the male gender accounts for approximately 55% of the population requiring aortic-mitral surgery [7, 9].

However, in our study, most of the population (56%) was female. Additionally, the average age in our study is relatively younger compared to similar studies, whereas in some studies, it appears to be relatively older than our group.

The average age in our group was 56.41 ± 10.35 years, while other groups report relatively older ages.

Gillinov et al. reported an average age of 60 ± 13.00 years [7], Urban et al. reported 67.2 ± 8.9 years [8], and Mueller et al. reported 68 ± 9.34 years [10]. If we consider these three factors together—the type of aortic valve pathology, gender, and age—one potential reason for the differences between our study group and the others may be the rheumatic etiology of the valvular disease, which is known to be more common in younger ages and females. Furthermore, it has been present in our population.

The operative data from our surgical teams demonstrated very satisfactory results. The extracorporeal circulation time was 121 ± 34.89 minutes, while the clamping time was 96 ± 24.46 minutes. It is well known that the duration of surgery, the time of cardiac arrest (or clamping), and the duration of extracorporeal circulation play a significant role in the procedure's outcomes.

These times primarily depend on the Experience of the entire surgical team. Several reports have found the following operative times: Husso et al. reported an average extracorporeal circulation time of 199 minutes and an average clamping time of 161 minutes [4]. Egger et al. [6] reported an average circulation time of 165 minutes and an average clamping time of 127 minutes, while Urban et al. [8], in a study similar to ours, reported clamping and extracorporeal circulation times of 95 ± 20 minutes and 125 ± 33 minutes, respectively.

Of course, extracorporeal circulation and clamping times are generally longer in multivalvular surgery cases than in isolated valve surgeries, thus constituting an added surgical risk. This is one of the key points where the surgical team must be particularly engaged, considering that the bivalvular surgical procedure is naturally longer in duration.

Low cardiac output following bivalvular surgery remains the most common cause of death in this type of surgery. The incidence of this complication in various studies ranges from 20% to 28.6% [2, 7, 8].

Management of this complication may involve pharmacological treatment with inotropic drugs as well as invasive circulatory assistance. In our study group, low cardiac output occurred in 17.4% of cases, and the treatment approach was primarily based on the use of positive inotropes.

Conduction disorders are significant in aortic-mitral valve surgery, as they are directly related to the surgical anatomy of the aortic and mitral valve interventions. We

considered cases of conduction disturbances managed with the implantation of a permanent pacemaker.

The incidence of this complication in our group was 8.3%. The results of two extensive studies related to this complication are as follows. Among 77,882 patients who underwent cardiac valve surgery, 4,202 patients (5.4%) underwent aortic valve replacement (AVR) combined with mitral valve replacement (MVR), and 1,069 patients (1.4%) underwent aortic valve replacement (AVR) combined with mitral valve repair (MVR).

The incidence of conduction disturbances treated with pacemaker implantation was 9.3% after AVR plus MVR and 13.3% after AVR plus MVR [11]. In another study involving 3,391 patients undergoing multivalvular surgery, 712 underwent a double valve procedure (aortic and mitral valve), and of these, 15.5% (111 patients) required permanent pacemaker implantation [12].

In direct comparison, our results regarding this complication are highly satisfactory. Double valve replacement itself is a significant risk factor for mortality (9.4%) compared to isolated mitral valve replacement (5.7%) or isolated aortic valve replacement (3.5%) [3].

These results, alongside other risk factors such as age, valve pathology, heart functional status, or other comorbidities, clearly indicate that simultaneous surgery is a significant risk factor and is naturally linked to the complexity of the bivalvular surgical procedure. In this presentation, we do not intend to analyze the risk factors in detail, but rather provide a brief overview of the raw results.

Two studies with a large number of cases, Leavitt et al. [9] with 1,057 patients and Gillinov et al. [7] at the Cleveland Clinic with 813 patients, reported hospital mortality rates of 15.5% and 7%, respectively. Several other studies in the literature, with a similar number of patients to our research, found hospital mortality rates ranging from 4% to 14% [4, 6, 8, 10, 13, 14, 15].

In our study, the hospital mortality was 6.6% among 121 patients, which is reasonably satisfactory compared to the studies above. The incidence is comparable to that of similar studies or as reported in significant cardiac surgery treatises.

Most of the articles and studies were retrospective or meta-analyses, often involving heterogeneous patient groups in terms of both number and patient characteristics, as well as the duration of follow-up. Under these conditions, it should be acknowledged that there are no clear recommendations or classic evidence-based guidelines for bi-valvular surgery [16, 17].

In other words, in cases where mitral and/or aortic valve disease is at an advanced stage, the indication for surgery has typically been determined based on the guidelines of European or American associations for managing heart valve diseases. Some cases in our study also had valve disease that, on its own, did not meet the indication for surgery if considered separately, according to the guidelines.

The cases we encountered included severe aortic valve stenosis with moderate mitral regurgitation or, more commonly, severe mitral stenosis combined with mild to moderate aortic valve stenosis.

In these cases, for bivalvular surgery, it must be acknowledged that there are no clearly defined recommendations or evidence-based guidelines. In such situations, the decision for surgery was personalized for each patient, taking into account various factors, including age, expected survival, valve anatomy, and cardiac function.

Based on these, the final surgical strategy was determined. This is one of the most crucial aspects that the entire surgical team should consider in aortic mitral valve surgery.

Conclusions

Surgical treatment of combined aortic and mitral valve disease remains the appropriate medical approach for this group of patients, with undeniable benefits in terms of survival and quality of life improvement.

Managing this patient group during the preoperative, operative, and postoperative phases remains challenging for any surgical team. In many cases, the final indication for surgery is determined on an individual basis by the surgical team. This surgical procedure in our clinic has excellent outcomes regarding hospital mortality and early postoperative complications.

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.

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