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ORIGINAL ARTICLES

Early Results of Simultaneous Aortic Valve and Ascending Aorta Surgery: 16-year Single-Center Experience

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Abstract

Introduction: Surgical treatment for the aortic valve and ascending aortic aneurysm is currently a frequently performed procedure. It is reported that up to 15% of patients requiring aortic valve surgery also need simultaneous surgical intervention of the ascending aorta.
The main objective of this study is to present, for the first time in our country, the early postoperative outcomes of combined aortic valve surgery and supra-commissural ascending aorta replacement. This study, being the first of its kind in our country, holds significant importance in the field of cardiovascular surgery.
Materials and Methods: This retrospective cohort study included patients who underwent simultaneous aortic valve surgery and supracommissural ascending aorta replacement between 2007 and 2023 at the Department of Cardiac Surgery, UHC 'Mother Teresa,' Tirana, Albania. Data were extracted from surgical registries and medical hospital records.
Results: A total of 131 patients participated in the study, consisting of 102 males (77.9%) and 29 females (22.1%). The average age of the cohort was 57.33 ± 11.90 years. The majority of patients (93.9%, 123/131) underwent elective surgery. Severe aortic valve stenosis was the most prevalent primary pathology, affecting 58 patients (44.3%). The in-hospital mortality rate was 2.29% (3/131 patients) …
Conclusion: Simultaneous aortic valve surgery and supra-commissural ascending aorta replacement at our institution is associated with excellent early postoperative outcomes, reassuring us of the effectiveness of this procedure in our practice.
Keywords: Aortic Valve, Ascending Aorta Aneurysm, Aortic Valve Replacement, Aortic Valve Stenosis, Ascending Aorta Replacement, Simultaneous Surgery

Introduction

Ascending aortic aneurism is frequently encountered in patients with aortic valve disease, mainly due to the strong correlation between congenital malformations of the aortic valve, leading to severe stenosis and/or aortic regurgitation and the development of ascending aortic aneurysm [1].

The simultaneous surgical management of aortic valve disease and ascending aortic aneurysm is a well-established procedure [2,3].

Patients undergoing simultaneous aortic valve surgery and ascending aorta repair are considered to have a higher incidence of complications and an increased operative risk than those undergoing isolated procedures for aortic valve replacement or ascending aorta repair. However, this com-

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bined surgical approach has been performed routinely at our institution for many years.

Materials and Methods:

This retrospective study analyzed 131 adult patients (aged over 18 years) who underwent simultaneous aortic valve and supra-commissural ascending aorta surgery at the Department of Cardiac Surgery, UHC 'Mother Teresa,' Tirana, Albania, between January 2007 and December 2023. The indications for surgery concerning the aortic valve and ascending aorta were determined based on established guidelines and cardiac surgery literature. In the absence of a primary indication for surgery, the indication for ascending aorta was primarily based on the dimensions of the ascending aorta being ≥ 45 mm [4,5,6,7].

However, a thorough evaluation was conducted in daily practice to determine whether to address the ascending aorta, considering additional patient-specific factors. Echocardiography and computed tomography served as the primary diagnostic tools for aortic valve pathology and ascending aorta aneurysm. The surgical procedures included aortic valve replacement and repair, as well as ascending aorta replacement and remodeling. Patients with endocarditis, acute aortic dissection, reoperations, procedures involving the aortic bulb, and other concomitant surgical interventions were excluded from the study.

Data were collected from hospital medical records and operating room registers. For each patient, the following information was gathered: general demographics, admission diagnosis, mode of admission, comorbidities, primary disease that led to hospitalization, operative times (clamp time and extracorporeal circulation time), time spent in the intensive care unit (ICU) (including directed respiratory support time and total duration of ICU stay), hospital mortality, and major postoperative complications (stroke, conduction disturbances, arrhythmias, infections, respiratory disorders, and reoperation for hemorrhage).

The data were 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 a single two-stage venous cannula. 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.

Initially, the ascending aorta is resected, adhering to the principle of removing as much diseased tissue as possible, followed by the replacement/repair of the aortic valve. Subsequently, the prosthetic tube is implanted, or the ascending aorta is remodeled. The distal and proximal anastomoses are performed, either reinforced or not, with Teflon strips depending on the quality and /or the thickness of the aortic wall.

The heart is desired, and the aorta is decamped. A temporary ventricular epicardial pacemaker lead is placed, drains are inserted, the sternum is closed using special steel wires, and the wound is closed in layers. Photos of the operating room are below.

Results

In Table 1, we presented a summary of the general characteristics and comorbidities of the patients. The study included 131 patients, with 77.9% (102/131) being male and 22.1% (29/131 pt) female. The average age of the patients was 57.33 ± 11.90 years. Most patients, 93.9% (123/131 pt), underwent elective procedures, while 6.1% (8/131) required urgent surgery.

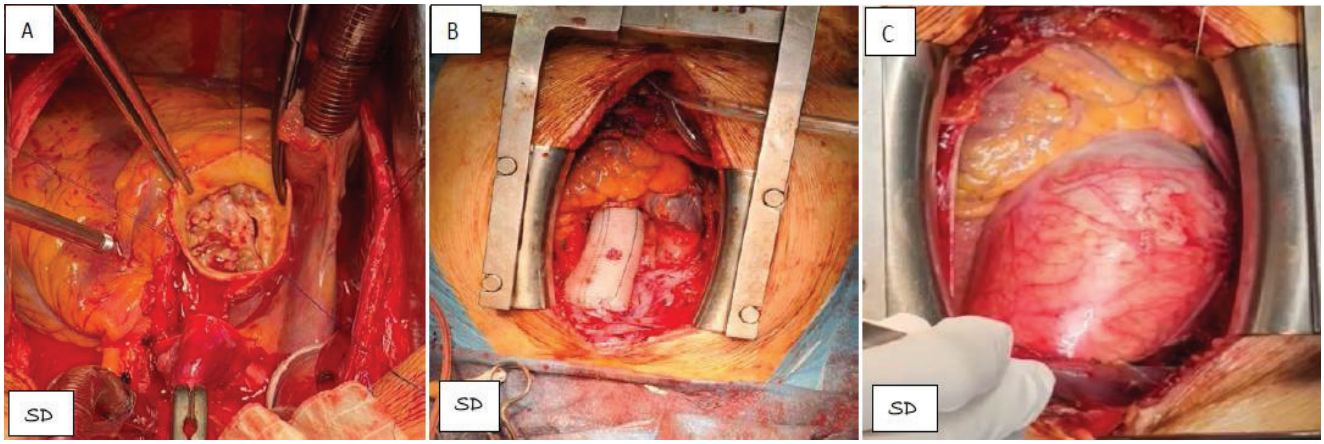

Figure 1: A-Stenotic calcified bicuspid aortic Valve, B-Ascending aorta replaced with a dacron prosthesis, C-Ascending Aorta Aneurysm

Data		No. of patients	mean ± SD or %
Age (years)		131	57.33±11.90
Gender	Male	102	77.9
	Female	29	22.1
Intervention	Elective	123	93.9
	Urgent	8	6.1
Primary diseases	AV	113	86.25
	AA	18	13.75
NYHA	II	62	47.3
	III	66	50.4
	IV	2	1.5
AVP	AVR	46	35,1
	AVS	58	44,3
	AVR+AVS	27	20,6
Aortic valve	BAV	68	51.9
	TAV	63	48.1
Aortic Valve	Replacement	128	97.7
	Repair	3	2.3
AAA	Replacement	123	93.9
Remodeling		8	6.1
Arterial hypertension		97	74.0
Kidney disease		1	0.8
Diabet mellitus		5	3.8
Peripheral arteriopathy		0	0,0
Obesity		4	3.1
COPD		1	0.8
Carotis stenosis		1	0.8

AV-Aortic Valve, AAA-Ascending Aorta Aneurysm, NYHA-New York Heart Association, AVP-Aortic Valve Pathology, AVR-Aortic Valve Regurgitation, AVS -Aortic Valve Stenosis, BAV-Bicuspid Aortic Valve, TAV-tricuspid Aortic Valve, COPD-Chronic obstructive pulmonary disease

Table 1: General Data and Comorbidities

Data	Mean	Standard deviation
Ejection Fraction (%)	59.20	9.08
Pulmonary Artery Systolic Pressure (PaSP) (mmHg)	40.21	12.29
Aortic Annulus Diameter (mm)	23.71	1.99
Posterior Wall Thickness (ThPW) (mm)	12.93	2.50
Septal Thickness (ThS) (mm)	14.31	2.68
Telediastolic Diameter (TDD) (mm)	57.31	7.65
Telesystolic Diameter (TSD) (mm)	39.62	8.15
Maximal Gradient (Max Grad) (mmHg)	84.67	28.53
Mean Gradient (Mean Grad) (mmHg)	49.30	18.30
Ascending Aorta Diameter (mm)	51.96	6.47

Table 2: Echocardiography Data

In 97.7% of cases (128/131 patients), patients were classified as NYHA functional class II and III, while NYHA class IV was observed in 2 patients (1.5%).

The most prevalent pathology affecting the aortic valve was aortic valve stenosis (AVS), which was found in 44.3% (58/131) of cases, followed by aortic valve regurgitation (AVR) in 35.1% (46/131) of cases.

Mixed pathology (AVS + AVR) was present in 20.6% (27/131) of patients.

The primary indication for surgery was aortic valve pathology in 86.25% (113/131) cases, while ascending aortic aneurysm was the primary indication in 13.75% (18/131) cases. A bicuspid aortic valve (BAV) was present in 51.9% (68/131) of patients. Aortic valve replacement was the predominant procedure, performed in 97.7% (128/131) of cases, with aortic valve repair carried out in 3 cases. Ascending aorta replacement was performed in 93.9% (123/131) of patients, while ascending aorta remodeling was performed in 8 cases.

The most common comorbidity was arterial hypertension, present in 74% (97/131) of patients, followed by diabetes mellitus in 3.8% (5/131) of patients. The echocardiographic data are summarized in Table 2.

Echocardiography data showed that the mean ejection fraction was 59.20±9.08%. The mean aortic annulus diameter was 23.71±1.99 mm, and the average mean gradient across the aortic valve was 49.30±18.30 mmHg. The average diameter of the ascending aorta, measured by echocardiography, was 51.96±6.47 mm.

Table 3 provides data on key operative and postoperative times.

The mean duration of extracorporeal circulation was 111.09 ± 23.67 minutes, while the average aortic cross-clamp time was 89.56 ± 20.71 minutes. The average length of stay in the ICU was 52.49 ± 33.97 hours, with an average duration of respiratory support of 10.48 ± 5.26 hours. The mean postoperative hospital stay was 9.55 ± 4.93 days.

Table 3: Operative and Postoperative Data

Table 4 presents data regarding the types (mechanical or biological) of aortic valve prostheses used, along with their respective brands and quantities. The biological prosthesis (SJM Epic Supra) was implanted in 17.5% (23/131) cases, while aortic valve repair was performed in 3 patients.

Mechanical prostheses were implanted in 80.1% (105/131) of patients, with the SJM Re-

Type/ No. of Prosthesis	No. of patients	%
SJM Standard	32	24.4
SJM Regent	70	53.4
SJM Epic Supra	23	17.5
ATS mechanical	3	2.29
Repair	3	2.29
Prosthesis Nr 19	6	4.5
Prosthesis Nr 21	22	16.7
Prosthesis Nr 23	61	46.5
Prosthesis Nr 24	2	1.5
Prosthesis Nr 25	31	23.6
Prosthesis Nr 27	6	4.5

Table 4: Number and Type of Aortic Valve Prosthesis

Data	No. of patients	%
Hospital Mortality	3	2.29
Low Cardiac Output	2	1.5
Stroke	1	0.8
Pulmonary Disease	1	0.8
Renal Insufficiency	1	0.8
Revision for Bleeding	3	2.29
New Atrial Fibrillation	19	14.5
Conduction Disorders	9	6.9

Table 5: Mortality and postoperative major complications

gent prosthesis being the most commonly used, implanted in 53.4% of cases.

The most frequently used prosthesis size was No. 23 (46.5%), followed by No. 25 (23.6%) and No. 21 (16.7%). The average diameter of the implanted prostheses was 23.15 ± 1.99 mm, which closely corresponds with the average aortic annulus diameter of 23.71 ± 1.99 mm, as measured by echocardiography.

Table 5 outlines the hospital mortality and major postoperative complications. The hospital mortality rate was 2.29% (3/131 patients). The most frequent postoperative complication was the onset of new atrial fibrillation, observed in 14.5% of patients, followed by conduction disturbances necessitating permanent pacemaker implantation in 6.9% (9/131) of patients. Postoperative hemorrhage requiring revision occurred in 2.29% (3/131) of cases.

Discussion

Aortic valve diseases are often linked with the dilation of the ascending aorta. Reports indicate that as many as 15% of patients undergoing aortic valve replacement have an ascending aortic aneurysm that necessitates concurrent surgical intervention [8]. One thousand two hundred fifty-seven patients underwent aortic valve surgery at our center between January 2007 and December 2023, of which 139 patients (11%) required surgery for the ascending aorta. Our study included 131 patients who underwent surgery for both the aortic valve and supracommissural ascending aorta, without any other associated pathologies.

This procedure is commonly performed, and its frequency aligns with what has been reported in the literature. The occurrence of this simultaneous surgical intervention, along with its higher operative risk compared to isolated aortic valve replacement or ascending aorta surgery, prompted us to review the outcomes for this patient cohort. To our knowledge, this is the first report on this surgical approach in our country.

Our patient series is substantial compared to major global cardiac surgical centers. The most extensive series reported were from Leipzig Heart Center [9], with 652 patients, and Brigham and Women's Hospital, Boston [10], with 571 patients, while other reports mentioned similar or smaller patient numbers compared to our study [11-16]. In our study, the majority of cases, 77.9% (102/131), were male.

This finding is consistent with nearly all published articles, which report a male gender range of 62.5%-76% [10, 12, 13, 15, 16]. The average age of patients undergoing simultaneous aortic valve and ascending aorta surgery was 57.33±11.90 years, reflecting the few comorbidities in our cohort.

Kaneko et al. [10] reported that patients over 60 years old comprised 76% of their cohort. Meanwhile, Sioris et al. [15] and Vendramin et al. [16] reported average ages of 61.4±13.4 years and 60.5±11.2 years, respectively. The most common clinical status on admission was NYHA II and III, observed in 97.7% of our cases.

Sioris et al. [15] reported that NYHA classes II and III combined constituted 73% of their patients. The fact that nearly all of our cohort belonged to NYHA classes II and III indicates that heart failure had progressed to advanced stages, significantly increasing operative risk and highlighting the need for greater emphasis on preventive healthcare.

Hypertension was the most common among comorbidities in 74% of cases. This is expected, as hypertension is a known risk factor for the development of ascending aortic aneurysm. In various reports, the prevalence of hypertension as a comorbidity ranged from 41%-82% [10, 12, 13, 15, 16].

Other comorbid conditions, possibly due to the relatively younger age of our patients, had a lower incidence compared to the literature. Diabetes mellitus was present in 3.8% of patients, while some studies reported its prevalence as 7%-14.5% [9, 10].

Aortic stenosis was the most common pathology affecting the aortic valve, observed in 58 patients (44.3%) with a mean maximum gradient of 84.67±28.53 mmHg and an average mean transvalvular gradient of 49.30±18.30 mmHg.

Peters et al. [13] reported that aortic stenosis was present in 65% of cases with an average gradient of 41.1±15.6 mmHg, while Sioris et al. [15] identified aortic stenosis as the primary pathology in 48% of their cohort. The second most common pathology was aortic valve regurgitation, found in 46 patients (35.1%), a finding consistent with data from other studies, where the incidence ranged from 25% to 35% [10, 13, 15].

The average ejection fraction (EF), our group's most common indicator of left ventricular function, was 59.20±9.08%. Peters et al. [13] reported an average EF of 56.8±10.4%, while Vendramin et al. [16] reported an average EF of 61.9±10.6%.

The average diameter of the ascending aorta was 51.96±6.47 mm. Concurrently, studies with larger cohorts, such as those by Haunschild et al. [9] and Kaneko et al. [10], reported average diameters of 47.3 ± 5 mm and 40.2 ± 4.2 mm, respectively. A distinctive aspect of these values is that they are smaller than the average diameter found in our study, likely because many cases in the studies above involved bicuspid aortas, for which the surgical approach to the ascending aorta was more aggressive for diameters between 40 and 45 mm. The average diameter of the aortic valve annulus, measured by echocardiography, was 23.71±1.99 mm, which corresponds closely with the average diameter of the implanted prosthesis, 23.15 mm.

Our operative data indicate that the mean cardiopulmonary bypass time was 111.09 ±23.67 minutes, and the mean aortic cross-clamp time was 89.56 ± 20.71 minutes.

These operative times are favorable compared to studies with similar patient numbers, such as Peterss et al. [13], who reported a mean bypass time of 144.1±25.7 minutes and a mean cross-clamp time of 99.8±13.9 minutes, Vendramin et al. [16], who reported longer operative times of 173.8±57.6 minutes and 131.8±38.6 minutes, and Vishal et al. [11], who reported an average bypass time of 150 minutes and a cross-clamp time of 121 minutes. Sioris et al. [15] reported times similar to ours, with a mean bypass time of 120±42 minutes and a mean cross-clamp time of 92±31 minutes. Our operational times suggest that this surgery can be performed efficiently in our center, with times comparable to those of major specialized centers worldwide. These favorable times are critical as they directly impact outcomes in cardiac surgery.

The postoperative stay in the ICU and hospital was 52.49 ± 33.97 hours and 9.55 ± 4.93 days, respectively. In the literature, nearly all studies report similar lengths of stay in the ICU and hospital [8-14]. In our study, postoperative atrial fibrillation was the most common complication, observed in 14.5% (19/131) of patients, while Winkler et al. [12] reported a postoperative atrial fibrillation incidence of 42.5%, and Peterss et al. [13] reported a rate of 9%. Conduction disturbances, which led to the implantation of a permanent pacemaker, were the second most common postoperative complication, reported in 6.9% (9/131) of cases in our study.

In a large study by the Leipzig Heart Team [9] involving 652 patients, permanent pacemaker implantation was reported in 2.3% of patients, a figure lower than ours. Postoperative bleeding that required surgical revision was observed in 2.29% of cases. Other complications, including low cardiac output and pulmonary or renal issues, were reported at very low rates of less than 1%.

In our cohort, there were three in-hospital deaths (3/131), or 2.29%. A review of the literature confirmed the excellent outcomes of our cardiac surgical team, both in terms of in-hospital mortality and postoperative complications.

The Leipzig Heart Team [9] reported an in-hospital mortality rate of 1.7%, whereas Brigham and Women's Hospital [10] reported a 0% mortality rate. Shah et al. [11] documented an in-hospital mortality rate of 1% among 198 patients, while Sioris et al. [15] reported a 5% mortality rate in a cohort of 131 patients.

Conclusions:

Aortic valve diseases that require surgical treatment are often linked to ascending aortic aneurysms. As a result, simultaneous aortic valve and ascending aorta surgery is standard practice in cardiac surgery. Surgical treatment remains the best and safest approach for this patient group, offering excellent outcomes and distinct benefits for the patients. In our clinic, this procedure reports outstanding early results concerning hospital mortality and perioperative complications compared to other international centers.

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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