ECHOCARDIOGRAPHIC TRACKING OF DIASTOLIC FUNCTION CHANGES AFTER SURGICAL AORTIC VALVE REPLACEMENT IN A TERTIARY HOSPITAL

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ABSTRACT:

Background: Right ventricular (RV) performance is an important determinant of prognosis in individuals with advanced aortic stenosis (AS) undergoing aortic valve replacement (AVR). While left ventricular changes after intervention are well described, the trajectory of RV function following surgical AVR (SAVR) and transcatheter aortic valve implantation (TAVI) has not been explored to the same extent.

Aim and Objectives: This study aimed to examine serial changes in RV systolic function using multiple echocardiographic indices after AVR in patients with severe AS and to compare the pattern of recovery between SAVR and TAVI.

Materials and Methods: A prospective observational study was conducted on 55 patients with severe AS who underwent AVR between April 2023 and March 2025. RV systolic performance was assessed before the procedure and at 6 weeks, 3 months, and 6 months post-intervention. Parameters included tricuspid annular plane systolic excursion (TAPSE), RV fractional area change (FAC), RV ejection fraction (RVEF), and RV longitudinal strain (RV LS). Changes over time were analyzed using repeated-measures ANOVA with Bonferroni adjustment for multiple comparisons.

Results: Significant improvement in RV systolic indices was observed during follow-up. Mean TAPSE increased from 18.2 ± 2.6 mm at baseline to 20.1 ± 2.4 mm at 6 months ($p < 0.001$). RV FAC rose from 37.7 ± 5.3% to 41.0 ± 5.0% ($p < 0.001$), RVEF from 46.8 ± 6.1% to 50.9 ± 5.7% ($p = 0.002$), and RV LS from −18.1 ± 2.8% to −20.4 ± 2.6% ($p < 0.001$). Both SAVR and TAVI cohorts demonstrated functional gains; however, patients treated with TAVI exhibited earlier improvement in TAPSE and RV LS at the 6-week assessment.

Conclusion: Aortic valve replacement leads to progressive enhancement of RV systolic performance within six months in patients with severe AS. Although both SAVR and TAVI yield meaningful long-term improvement, TAVI appears to facilitate quicker early recovery of RV function.

Keywords: Aortic stenosis; right ventricular systolic function; aortic valve replacement; transcatheter aortic valve implantation; echocardiography; TAPSE; RV strain; RV fractional area change.

Introduction:

Severe aortic stenosis (AS) imposes a sustained pressure load on the left ventricle, leading to concentric hypertrophy, reduced ventricular compliance, and progressive impairment of relaxation. Over time, these structural and functional adaptations result in elevated filling pressures and symptoms consistent with heart failure, even when left ventricular ejection fraction remains within the normal range. Consequently, abnormalities in diastolic function are highly prevalent in patients with advanced AS and carry important prognostic implications both before and after aortic valve intervention.

Echocardiography remains the principal tool for evaluating left ventricular diastolic performance in this population. Standard parameters—including transmitral early (E) and late (A) inflow velocities, tissue Doppler–derived early diastolic annular velocity (e′), the E/e′ ratio, deceleration time (DT), and left atrial volume index (LAVI)—provide complementary information regarding ventricular relaxation, filling pressures, and atrial remodeling. These indices not only characterize the severity of diastolic dysfunction but also help predict postoperative outcomes and guide follow-up after aortic valve replacement (AVR).

Relief of outflow obstruction through surgical AVR (SAVR) or transcatheter aortic valve replacement (TAVR) improves survival and functional status in patients with severe AS. Nonetheless, the degree and timing of diastolic recovery after intervention are variable. While left ventricular afterload reduction is expected to lower filling pressures and enhance compliance, the extent of reverse remodeling depends on several factors, including the chronicity of pressure overload, the presence of myocardial fibrosis, and coexisting cardiovascular conditions. Some reports suggest that transcatheter approaches may facilitate earlier hemodynamic improvement by avoiding cardiopulmonary bypass and minimizing perioperative myocardial injury, potentially leading to more rapid normalization of filling dynamics. However, the durability and magnitude of these changes over intermediate follow-up remain uncertain.

Previous investigations have demonstrated that improvements in filling pressures, reflected by reductions in E/e′ ratio and related indices, may occur relatively early after valve intervention. In contrast, structural adaptations such as left atrial volume regression and normalization of transmitral flow patterns often evolve more gradually over subsequent months. Moreover, a subset of patients continues to exhibit persistent or only partially reversible diastolic dysfunction despite technically successful valve replacement, underscoring the heterogeneity of myocardial remodeling in this setting. Identifying patterns of recovery and factors associated with incomplete improvement is therefore essential for risk stratification and postoperative management.

In this context, the present prospective observational study was designed to systematically assess changes in left ventricular diastolic function in patients with severe AS undergoing AVR. Using a comprehensive echocardiographic approach—including transmitral flow velocities, tissue Doppler indices, E/e′ ratio, deceleration time, and left atrial volume index—we evaluated patients at baseline and at serial follow-up intervals of 6 weeks, 3 months, and 6 months after either SAVR or TAVR. By comparing temporal trends between treatment modalities, this study aims to clarify patterns of diastolic

recovery, improve understanding of post-procedural ventricular remodeling, and help identify patients at risk for persistent diastolic impairment following valve replacement.

AIM AND OBJECTIVE OF THE STUDY

To evaluate the prevalence of hypomagnesaemia in patients with type 2 diabetes mellitus and to assess its association with glycaemic control.

Objectives

1. To determine the prevalence of hypomagnesaemia among patients with type 2 diabetes mellitus.
2. To estimate serum magnesium levels in patients with type 2 diabetes mellitus.

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Cardiology and general medicine , sree mookambika institute of medical sciences , from April 2023 to March 2025, to evaluate temporal changes in echocardiographic indices and clinical status in patients with severe aortic stenosis (AS) undergoing aortic valve replacement (AVR). Patients aged ≥18 years with symptomatic severe AS—defined as an aortic valve area (AVA) <1.0 cm^2 or indexed AVA <0.6 cm^2/m^2, mean pressure gradient ≥40 mmHg, or peak aortic jet velocity ≥4.0 m/s—were screened. Both high-gradient and low-gradient AS with preserved or reduced left ventricular ejection fraction (LVEF) were eligible. Exclusion criteria included contraindications to antiplatelet or anticoagulant therapy, severe contrast allergy, sepsis, significant symptomatic carotid/vertebral artery stenosis or abdominal aortic aneurysm, bleeding diathesis, creatinine clearance <20 mL/min, reduced life expectancy due to malignancy, and refusal to provide written informed consent. Ethical approval was obtained from the Institutional Ethics Committee, and all participants provided written informed consent.

Baseline evaluation included demographics, clinical variables (NYHA class, comorbidities, prior cardiac history, STS score, vitals), and preoperative echocardiographic parameters. Echocardiographic assessment encompassed aortic valve measurements (AVAi, DVI, mean and peak pressure gradients, stroke volume), left ventricular indices (LVEF, LVEDD, LVESD, IVST, LVPWT, RWT, LVMI), diastolic function indices (E, A, e′, a′ velocities, E/e′ ratio, deceleration time, left atrial volume index), and right ventricular function (TAPSE, RVFAC, RVEF, RV MPI, RVSP, RV LS, RV s′). Echocardiograms were performed using standard parasternal, apical, suprasternal, and subcostal views, and transvalvular gradients were calculated using continuous-wave Doppler and the Bernoulli equation. Post-procedural aortic regurgitation and paravalvular leak were graded from 1 to 4. Follow-up echocardiography and clinical assessment were conducted at 6 weeks, 3 months, and 6 months after AVR to evaluate the progression and recovery of both systolic and diastolic function.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS). Quantitative data were expressed as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Independent t-tests were used to compare continuous variables after verifying normal distribution. Chi-square tests were applied to analyze differences

between categorical variables. Logistic regression models were used to adjust for age and estimate the independent effects of hypertension, ischemic heart disease, and diabetes mellitus. A p-value of less than 0.05 was considered statistically significant.

Results:

Baseline Characteristics

A total of 55 patients with high-risk severe aortic stenosis were included. The mean age was 78.44 ± 4.12 years (range: 71–88 years), with 69.09% aged 71–80 years and 30.91% aged 81–90 years. Males comprised 74.55% of the cohort, with a male-to-female ratio of 2.93. The mean BMI was 21.96 ± 2.27 kg/m², with most patients (89.09%) having a BMI of 18.5–24.9 kg/m².

NYHA functional class distribution showed that 47.27% had Class IV, 32.73% had Class III, and 20% had Class II symptoms. Hypertension (76.36%), coronary artery disease (49.09%), and diabetes mellitus (36.36%) were the most common comorbidities. The mean STS score was 7.11 ± 2.49, with 74.55% of patients scoring between 4 and 8.

Table 1. Baseline characteristics of the study population (N = 55)

Parameter	Category	n	% / Mean ± SD
Age (years)	71–80	38	69.09%
	81–90	17	30.91%
Mean age	—	—	78.44 ± 4.12
Gender	Male	41	74.55%
	Female	14	25.45%
BMI (kg/m²)	18.5–24.9	49	89.09%
	25–29.9	6	10.91%
Mean BMI	—	—	21.96 ± 2.27
NYHA class	II	11	20%
	III	18	32.73%
	IV	26	47.27%
Comorbidities	Hypertension	42	76.36%
	CAD	27	49.09%
	DM	20	36.36%
	CLD	17	30.91%
	CKD	11	20.00%
	Atrial fibrillation	6	10.91%
	Old CVA	5	9.09%
	Previous MI	3	5.45%
	Prior CABG	2	3.64%
STS score	4–8	41	74.55%
	> 8	14	25.45%
Mean STS score	—	—	7.11 ± 2.49

Diastolic Function Parameters

Early (E) and Late (A) Diastolic Mitral Inflow Velocities

E velocity increased significantly from 84.51 ± 14.63 cm/s at baseline to 92.07 ± 14.73 cm/s at 6 weeks, maintaining higher values at subsequent follow-ups ($p < 0.0001$).

A velocity also increased from 96.80 ± 14.63 cm/s at baseline to 102.53 ± 14.65 cm/s at 6 months ($p < 0.0001$), with a slight decline at 3 months.

Early Diastolic Mitral Annular Velocity (e')

e′ velocity improved from 3.70 ± 0.71 cm/s at baseline to 4.26 ± 0.67 cm/s at 6 months ($p < 0.0001$), peaking at 6 weeks.

Table 2. Changes in E, A, and e′ velocities

Parameter	Baseline	6 weeks	3 months	6 months	p-value
E velocity (cm/s)	84.51 ± 14.63	92.07 ± 14.73	90.89 ± 15.82	90.58 ± 16.10	< 0.0001
A velocity (cm/s)	96.80 ± 14.63	101.11 ± 15.79	101.26 ± 14.58	102.53 ± 14.65	< 0.0001
e′ velocity (cm/s)	3.70 ± 0.71	4.60 ± 0.70	4.40 ± 0.68	4.26 ± 0.67	< 0.0001

Other Diastolic Indices

Late Diastolic Annular Velocity (a')

a′ velocity decreased progressively from 7.09 ± 1.26 cm/s at baseline to 6.68 ± 1.23 cm/s at 6 months ($p < 0.0001$).

E/e′ Ratio

E/e′ ratio reduced significantly from 23.19 ± 3.92 at baseline to 21.51 ± 3.69 at 6 months ($p < 0.0001$).

Deceleration Time (DT)

DT increased markedly from 198.36 ± 23.55 ms at baseline to 257.46 ± 25.60 ms at 6 months ($p < 0.0001$).

Table 3. Changes in a′ velocity, E/e′ ratio, and DT

Parameter	Baseline	6 weeks	3 months	6 months	p-value
a′ velocity (cm/s)	7.09 ± 1.26	6.85 ± 1.23	6.75 ± 1.22	6.68 ± 1.23	< 0.0001

E/e′ ratio	23.19 ± 3.92	20.18 ± 2.83	20.84 ± 3.32	21.51 ± 3.69	< 0.0001
DT (ms)	198.36 ± 23.55	223.00 ± 22.43	244.60 ± 24.37	257.46 ± 25.60	< 0.0001

Left Atrial Volume Index (LAVI)

LAVI showed only minor changes during follow-up, with no substantial trend toward reduction, moving from 48.53 ± 9.78 mL/m² at baseline to 48.89 ± 9.74 mL/m² at 6 months ($p < 0.0001$).

Table 4. Changes in LAVI

Time point	LAVI (mL/m²)	p-value
Baseline	48.53 ± 9.78	—
6 weeks	47.87 ± 9.59	< 0.0001
3 months	48.42 ± 9.66	< 0.0001
6 months	48.89 ± 9.74	< 0.0001

Discussion

Diastolic dysfunction is highly prevalent in patients with advanced aortic stenosis because chronic pressure overload promotes concentric hypertrophy, increased myocardial stiffness, and impaired ventricular relaxation. Although aortic valve replacement reduces afterload and is expected to improve filling dynamics, the extent and timing of diastolic recovery after intervention remain variable. The present study examined serial echocardiographic changes after both surgical and transcatheter valve replacement in a high-risk elderly population and provides additional insight into the pattern of recovery over the first six months.

At baseline, the study group reflected a typical severe AS cohort, with advanced age, a predominance of men, and a high burden of functional limitation. Following valve replacement, multiple indices of diastolic performance showed progressive improvement. Increases in early diastolic velocities and tissue Doppler e′ suggested better myocardial relaxation, while reductions in E/e′ ratio indicated declining filling pressures. Prolongation of deceleration time further supported improved ventricular compliance. These favorable trends were evident across both procedural approaches, confirming that relief of valvular obstruction leads to measurable functional recovery of diastolic performance.

However, the trajectory of improvement differed between modalities. Patients undergoing transcatheter replacement demonstrated earlier gains in selected parameters, particularly e′ velocity, during the initial follow-up period. This pattern may reflect reduced perioperative myocardial stress and avoidance of cardiopulmonary bypass, which can influence early ventricular relaxation. Despite this early advantage, both groups demonstrated comparable overall improvement by six months, indicating that longer-term recovery is achievable irrespective of the technique used.

An important observation was the persistence of enlarged left atrial volume in many patients despite improvement in Doppler-derived indices. This suggests that structural remodeling lags behind functional recovery. While filling pressures may decline relatively soon after intervention, reversal of atrial enlargement and chronic myocardial changes appears to require a longer timeframe. In addition, a slight

attenuation of improvement in some parameters at later follow-up points indicates that diastolic recovery may plateau in certain individuals. Residual myocardial fibrosis, longstanding hypertrophy, and comorbid conditions such as hypertension or metabolic disease likely contribute to this heterogeneity.

Overall, the findings highlight that diastolic function after aortic valve replacement improves progressively but not uniformly. Both surgical and transcatheter approaches offer meaningful benefits, with transcatheter therapy showing earlier functional gains in high-risk patients. Persistent structural abnormalities underscore the need for continued surveillance beyond the early postoperative period. Larger studies incorporating longer follow-up and advanced imaging to quantify myocardial fibrosis would help clarify mechanisms of reverse remodeling and identify predictors of incomplete recovery, ultimately guiding patient selection and post-procedural care.

Conclusion:

Aortic valve replacement, whether via TAVR or SAVR, led to significant improvements in multiple echocardiographic measures of diastolic function in severe AS patients over 6 months, with TAVR demonstrating more rapid early gains. Persistent structural abnormalities such as elevated LAVI underscore the incomplete reversal of chronic remodeling in the short term. Early improvement in diastolic function after TAVR may be clinically advantageous in patients with advanced diastolic dysfunction, but sustained recovery likely requires longer follow-up.

Conflict of interest statement:
There is no conflict of interest among the authors.

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