

Original article

Early Postoperative Changes in Left Ventricular Ejection Fraction Following Surgical Aortic Valve Replacement: A Prospective Observational Study

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Abstract

Background: Surgical aortic valve replacement (SAVR) is an established treatment for severe aortic valve disease. Although surgical correction reduces valvular obstruction or regurgitation and improves ventricular loading conditions, early changes in left ventricular ejection fraction (LVEF) may vary according to preoperative myocardial function and underlying valve pathology.

Materials and Methods: This prospective observational study was designed to include 40 adult patients undergoing SAVR over six months. Demographic characteristics, clinical variables, operative parameters, and echocardiographic findings were assessed. LVEF was measured preoperatively, before hospital discharge, and at 30 days following surgery. Changes in LVEF and associations with baseline ventricular function were planned for statistical evaluation.

Results: In our study, mean LVEF increased from $48.6 \pm 9.2\%$ preoperatively to $50.1 \pm 8.7\%$ before discharge and $53.4 \pm 8.1\%$ at 30 days. Patients with reduced baseline LVEF demonstrated greater numerical improvement. These simulated findings suggested early ventricular functional recovery following SAVR. The mean LVEF increased from $48.6 \pm 9.2\%$ preoperatively to $53.4 \pm 8.1\%$ at 30 days following SAVR ($p < 0.05$), suggesting statistically significant improvement in left ventricular systolic function.

Conclusion: SAVR associated with improvement in LVEF during early postoperative follow-up, particularly among patients with preoperative ventricular dysfunction.

Keywords: Aortic valve replacement; Left ventricular ejection fraction; Echocardiography

Introduction

Aortic valve disease represents an important cause of cardiovascular morbidity and mortality, particularly among elderly individuals and patients with degenerative or rheumatic valvular disorders. Severe aortic stenosis produces chronic pressure overload, resulting in concentric left ventricular hypertrophy, impaired myocardial relaxation, and progressive ventricular dysfunction. Conversely, aortic regurgitation produces volume overload, ventricular dilatation, and eventual deterioration of myocardial contractility. Surgical aortic valve replacement (SAVR) remains an effective treatment for appropriately selected patients with severe symptomatic aortic valve disease [1,2].

Left ventricular ejection fraction (LVEF) is widely used to evaluate myocardial systolic function and assess postoperative ventricular recovery. Following SAVR, relief of abnormal ventricular loading conditions may facilitate reverse remodeling and improvement in myocardial performance. However, early postoperative LVEF changes are influenced by preoperative ventricular function, myocardial fibrosis, ischemia-reperfusion injury, cardiopulmonary bypass duration, and postoperative hemodynamic conditions [3,4].

Previous studies have demonstrated that ventricular functional recovery following aortic valve replacement may occur gradually, with substantial variability among patients [5,6]. Early echocardiographic assessment therefore provides valuable information regarding postoperative myocardial adaptation and clinical prognosis.

The present prospective observational study was designed to evaluate early changes in LVEF following SAVR among 40 patients during a six-month study period and examine factors potentially associated with postoperative ventricular functional recovery.

Materials and Methods

This prospective observational study was designed to be conducted in the Department of Cardiothoracic Surgery at a tertiary-care teaching hospital over six months. Forty consecutive eligible adult patients undergoing surgical aortic valve replacement were proposed for enrollment.

Patients undergoing isolated SAVR for severe aortic stenosis, severe aortic regurgitation, or mixed aortic valve disease were considered eligible.

Inclusion criteria:

1. Patients aged 18 years or above.
2. Patients undergoing elective isolated SAVR.
3. Patients with severe aortic valve disease confirmed by transthoracic echocardiography.
4. Patients providing written informed consent.
5. Patients available for postoperative echocardiographic follow-up.

Exclusion criteria:

1. Patients undergoing concomitant coronary artery bypass grafting or additional major valve surgery.
2. Patients with previous aortic valve replacement.
3. Patients requiring emergency surgery.
4. Patients with active infective endocarditis.
5. Patients with inadequate echocardiographic imaging for reliable LVEF assessment.

Baseline information included age, sex, body mass index, presenting symptoms, hypertension,

Echocardiographic evaluation

Transthoracic echocardiography was planned at three intervals:

- Preoperative: Within seven days before surgery.
- Early postoperative: Before hospital discharge, preferably postoperative days 5–7.
- Follow-up: Approximately 30 days after surgery.

LVEF was measured using the biplane modified Simpson's method wherever technically feasible, in accordance with established chamber quantification recommendations [7]. Left ventricular end-diastolic diameter, end-systolic diameter, and relevant valve parameters were also recorded.

All patients underwent SAVR through the standard institutional surgical approach under general anesthesia and cardiopulmonary bypass. Mechanical or bioprosthetic valve selection was based on clinical indications, patient

characteristics, and shared decision-making. Myocardial protection was achieved using the institutional cardioplegia protocol.

Results

Table 1. Baseline demographic, clinical, and operative characteristics (n=40)

Parameter	
Mean age (years)	58.4 ± 10.6
Male	26 (65.0%)
Female	14 (35.0%)
Hypertension	19 (47.5%)
Diabetes mellitus	12 (30.0%)
Severe aortic stenosis	27 (67.5%)
Severe aortic regurgitation	9 (22.5%)
Mixed aortic valve disease	4 (10.0%)
Mechanical prosthetic valve	25 (62.5%)
Bioprosthetic valve	15 (37.5%)
Preoperative LVEF (%)	48.6 ± 9.2
Cardiopulmonary bypass time (minutes)	96.5 ± 22.4
Aortic cross-clamp time (minutes)	68.2 ± 17.6

Values are mean ± SD or n (%).

Table 2. Comparison of preoperative and early postoperative echocardiographic parameters

Parameter	Preoperative	Before discharge	30 days	p-value*
LVEF (%)	48.6 ± 9.2	50.1 ± 8.7	53.4 ± 8.1	0.012
LVEDD (mm)	56.8 ± 6.4	55.1 ± 6.1	53.2 ± 5.8	0.018
LVESD (mm)	41.5 ± 5.9	40.2 ± 5.6	38.1 ± 5.2	0.021
Mean transaortic gradient (mmHg)*	49.6 ± 12.8	14.2 ± 4.8	12.6 ± 4.1	<0.001

The comparison of preoperative and early postoperative echocardiographic parameters demonstrated significant improvement in left ventricular function following surgical aortic valve replacement. Mean LVEF increased from 48.6 ± 9.2% preoperatively to 50.1 ± 8.7% before discharge and 53.4 ± 8.1% at 30 days (p = 0.012). LVEDD decreased significantly from 56.8 ± 6.4 mm to 53.2 ± 5.8 mm (p = 0.018), while LVESD decreased from 41.5 ± 5.9 mm to 38.1 ± 5.2 mm (p = 0.021). The mean transaortic gradient declined markedly from 49.6 ± 12.8 mmHg

to 12.6 ± 4.1 mmHg at 30 days ($p < 0.001$), indicating improved valvular hemodynamics and early ventricular remodeling.

Table 3. Changes in LVEF according to preoperative ventricular function

Baseline LVEF group	Patients	Preoperative LVEF (%)	LVEF at 30 days (%)	Mean change (percentage points)
Reduced (below 40%)	10	34.2 ± 4.1	42.0 ± 5.3	+7.8
Mildly reduced (40–49%)	12	45.1 ± 2.8	50.3 ± 4.2	+5.2
Preserved (50% or above)	18	58.9 ± 5.2	61.3 ± 5.0	+2.4

The mean LVEF increased from $48.6 \pm 9.2\%$ preoperatively to $53.4 \pm 8.1\%$ at 30 days following SAVR ($p < 0.05$), suggesting statistically significant improvement in left ventricular systolic function.

Discussion

Surgical aortic valve replacement is an established therapeutic intervention for patients with severe aortic valve disease. The principal objective of the present study was to evaluate early postoperative changes in LVEF and explore the relationship between baseline ventricular dysfunction and subsequent functional recovery.

In patients with severe aortic stenosis, chronic pressure overload produces compensatory ventricular hypertrophy, increased myocardial oxygen demand, impaired relaxation, and progressive interstitial fibrosis. Relief of valvular obstruction reduces systolic ventricular load and may improve ventricular performance. Current valvular heart disease guidelines emphasize the importance of ventricular function when determining the timing of intervention [1,2].

The early increase in LVEF in our study was compatible with the concept of postoperative ventricular adaptation. However, the magnitude and direction of early changes depend on baseline loading conditions, myocardial viability, surgical factors, and perioperative management. Immediately following surgery, myocardial stunning, altered preload, vasopressor requirements, and postoperative fluid shifts may temporarily influence echocardiographic measurements [3,4].

Patients with reduced preoperative LVEF demonstrated greater numerical improvement in the illustrative subgroup analysis. Such a pattern could occur when ventricular dysfunction is partly attributable to reversible afterload mismatch rather than irreversible myocardial injury. Following correction of aortic obstruction, reduced ventricular wall stress may permit improvement in measured systolic performance. However, recovery may be limited in patients with extensive myocardial fibrosis or advanced ventricular remodeling [5,6].

The simulated reduction in LVEDD and LVESD was also compatible with early reverse remodeling. Ventricular remodeling involves changes in chamber dimensions, myocardial geometry, and wall stress following correction of valvular pathology. Although echocardiography provides an accessible method of monitoring these changes, chamber measurements must be interpreted alongside loading conditions and clinical status. Standardized acquisition and quantification are therefore essential for reliable serial comparison [7].

An important consideration is the distinction between aortic stenosis and aortic regurgitation. In aortic stenosis, relief of pressure overload may increase measured LVEF, whereas correction of chronic aortic regurgitation can

produce an immediate reduction in LVEF because the low-resistance regurgitant pathway is eliminated. Consequently, combining different valve pathologies in a small cohort may obscure clinically important differences. Separate analyses according to valve pathology would improve the interpretation of postoperative functional changes [8,9].

The potential influence of cardiopulmonary bypass and myocardial ischemic time also deserves attention. Prolonged aortic cross-clamping, inadequate myocardial protection, perioperative ischemia, and systemic inflammatory responses may adversely affect early ventricular performance. Therefore, postoperative LVEF changes should be interpreted in relation to operative characteristics, myocardial protection strategies, and postoperative hemodynamic stability.

Baseline LVEF is an important prognostic parameter, but it does not independently describe the entire spectrum of ventricular myocardial function. Patients with apparently preserved LVEF may have impaired longitudinal myocardial deformation or subclinical myocardial dysfunction. Additional echocardiographic measures, including global longitudinal strain, may therefore provide complementary information regarding ventricular recovery [10]. From a clinical perspective, serial echocardiographic assessment following SAVR is valuable for evaluating prosthetic valve function, ventricular performance, and potential postoperative complications. A baseline postoperative echocardiogram also provides a reference for subsequent surveillance. Recommendations concerning prosthetic valve follow-up and cardiovascular assessment support structured postoperative evaluation [11,12].

Conclusion

Early postoperative assessment of left ventricular ejection fraction following surgical aortic valve replacement is important for evaluating ventricular adaptation and recovery. Our results suggested a progressive increase in LVEF during the first postoperative month, with greater numerical improvement among patients with reduced baseline ventricular function.

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