

Article

Severe Versus Mild–Moderate Pulmonary Hypertension: Outcomes Following Mechanical Mitral Valve Replacement with Posterior Leaflet Preservation

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Abstract

Background: Pulmonary hypertension is common in left-sided heart valve disease, with historical studies reporting mortality rates up to 31% in severe cases undergoing mitral valve surgery. This study evaluates the impact of severe pulmonary hypertension on outcomes of mechanical mitral valve replacement with posterior leaflet preservation by comparing results with patients having mild-to-moderate pulmonary hypertension. **Methods:** Prospective analysis of 86 patients with mitral valve disease undergoing mechanical valve replacement with posterior leaflet preservation from March 2015 to September 2016 was conducted. Patients were stratified by pulmonary artery pressure: severe (≥ 60 mmHg, $n = 19$) versus mild–moderate (35–59 mmHg, $n = 67$). Primary outcomes included mortality, complications, and functional recovery at 1, 6, and 12 months. **Results:** The cohort included 67 patients (77.9%) with mild–moderate pulmonary hypertension and 19 patients (22.1%) with severe pulmonary hypertension. Severe pulmonary hypertension patients demonstrated higher NYHA functional class (73.7% class III vs. 46.2%, $p = 0.03$), larger left atrial diameter (56.3 ± 9.8 vs. 49.5 ± 6.7 mm, $p = 0.01$), and higher mean pressure gradients (14.4 ± 5.3 vs. 11.3 ± 5.0 mmHg, $p = 0.025$). Mortality was 5.3% in the severe group versus 0% in the mild–moderate group ($p = 0.331$). Patients with severe pulmonary hypertension required longer ICU stays (6.3 ± 3.7 vs. 4.7 ± 2.2 days, $p = 0.024$) but showed no significant differences in ventilation time, reoperation rates, or major complications. At the 12-month follow-up, both groups achieved equivalent outcomes in pulmonary artery pressures, left ventricular function, and cardiac dimensions. **Conclusion:** In this study with a relatively small sample size, severe pulmonary hypertension was associated with significantly longer intensive care unit stay but not with higher mortality compared to mild–moderate pulmonary hypertension, with both groups attaining comparable functional and hemodynamic parameters at 12 months after mechanical mitral valve replacement with posterior leaflet preservation.

Keywords: mitral valve replacement; pulmonary hypertension; posterior leaflet preservation; mechanical valve; cardiac surgery outcomes



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1. Introduction

Rheumatic heart disease remains a significant global health burden, affecting over 33 million people worldwide and resulting in approximately 320,000 deaths annually, particularly in developing countries where it continues to be the leading cause of valvular heart disease [1,2]. Mitral valve disease represents the most common manifestation of rheumatic pathology, frequently progressing to severe mitral regurgitation or stenosis with associated pulmonary hypertension due to retrograde blood stasis, increased left atrial pressure, and subsequent pulmonary vascular remodeling [3,4]. Historically, severe pulmonary hypertension has been considered a formidable risk factor in mitral valve surgery, with early studies from the 1970s reporting mortality rates as high as 31–61% in patients with severe pulmonary hypertension undergoing mitral valve replacement [5,6]. However, recent evidence suggests a paradigm shift in surgical outcomes, with contemporary studies demonstrating significantly improved mortality rates ranging from 4 to 12% in patients with severe pulmonary hypertension, challenging the traditional perception of prohibitive operative risk [2,7]. These improvements have been attributed to advances in surgical techniques, including the growing adoption of posterior leaflet preservation during mechanical mitral valve replacement, which maintains left ventricular geometry, preserves systolic function, and improves postoperative hemodynamics compared to conventional replacement techniques [8,9]. Multiple recent investigations have demonstrated that preservation of the subvalvular apparatus during mitral valve replacement results in better preservation of left ventricular function, reduced postoperative morbidity, and improved long-term outcome [10,11]. Current literature regarding mitral valve surgery in rheumatic heart disease presents conflicting evidence about optimal surgical strategies, with some studies suggesting superior outcomes with repair when feasible, while others demonstrate comparable long-term results between repair and replacement, particularly noting higher reoperation rates in the rheumatic population [12,13]. Despite these advances in surgical techniques and perioperative management, there remains limited specific data examining the outcomes of mechanical mitral valve replacement with posterior leaflet preservation in patients with severe pulmonary hypertension [14]. Therefore, this study aims to evaluate the clinical outcomes of mechanical mitral valve replacement with preservation of the posterior leaflet specifically in patients with severe pulmonary hypertension, comparing results with those patients having mild-to-moderate pulmonary hypertension to determine whether contemporary surgical techniques have indeed mitigated the historical risks associated with severe pulmonary hypertension in this specific surgical context.

2. Materials and Methods

2.1. Study Population

This prospective controlled descriptive study included 86 consecutive patients with mitral valve disease who underwent mechanical mitral valve replacement with preservation of the posterior leaflet at Hue Central Hospital from March 2015 to September 2016. All patients were indicated for surgery according to the 2014 ACC/AHA guidelines for valvular heart disease and had documented pulmonary hypertension on preoperative echocardiography. Institutional review board approval was obtained, and all patients provided informed consent for participation.

2.2. Selection Criteria

Inclusion criteria comprised patients with mitral valve disease requiring valve replacement, documented pulmonary hypertension on echocardiography, and consent to participate in the study. Exclusion criteria included concomitant aortic valve disease, coronary

artery disease requiring bypass grafting, congenital heart disease, and primary pulmonary hypertension to eliminate confounding factors that could influence surgical outcomes.

2.3. Patient Classification and Assessment

Patients were stratified into two groups based on systolic pulmonary artery pressure measured by transthoracic echocardiography: severe pulmonary hypertension (≥ 60 mmHg) and mild–moderate pulmonary hypertension (35–59 mmHg). Right ventricular systolic pressure, measured via transthoracic echocardiography, was used to estimate pulmonary systolic pressure in the absence of right ventricular outflow tract obstruction. Preoperative evaluation included a comprehensive clinical assessment (age, gender, body surface area, NYHA functional class, comorbidities), chest radiography, and detailed echocardiographic parameters including left ventricular dimensions, ejection fraction, left atrial diameter, and transvalvular pressure gradients.

2.4. Surgical Technique

All procedures were performed using standard cardiopulmonary bypass with cardioplegic arrest. The mitral valve replacement with the posterior leaflet preservation technique involved complete preservation of the posterior leaflet and its associated chordae tendineae and papillary muscle attachments. The anterior leaflet was excised, while the posterior leaflet remained intact to maintain left ventricular geometry and function. Mechanical prostheses were implanted with interrupted pledgeted sutures, ensuring no interference with the preserved posterior leaflet apparatus.

2.5. Outcome Measures and Follow-Up

Primary outcomes included in-hospital mortality, early postoperative complications, and major adverse cardiac events. Secondary outcomes encompassed mechanical ventilation time, intensive care unit length of stay, reoperation for bleeding, and echocardiographic parameters. Patients were systematically followed at 1, 6, and 12 months postoperatively with clinical assessment and transthoracic echocardiography to evaluate left ventricular function, prosthetic valve function, pulmonary artery pressures, and cardiac dimensions.

2.6. Statistical Analysis

Continuous variables were expressed as mean $\pm$ standard deviation and compared using Student's *t*-test for normally distributed data or Mann–Whitney U test for non-normally distributed data. Categorical variables were presented as frequencies and percentages and compared using chi-square test for expected frequencies ≥ 5 or Fisher's exact test for expected frequencies < 5 . Statistical significance was set at $p < 0.05$. All analyses were performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA).

3. Results

3.1. Baseline Characteristic and Preoperative Clinical Status

The study cohort comprised 86 patients, with 19 patients (22.1%) classified as having severe pulmonary hypertension and 67 patients (77.9%) having mild–moderate pulmonary hypertension. Baseline demographic characteristics were generally similar between groups, with mean ages of 44.7 ± 10.2 years in the severe group versus 47.7 ± 9.1 years in the mild–moderate group ($p = 0.211$). Male gender was more prevalent in the severe pulmonary hypertension group (42.1% vs. 23.9%, $p = 0.165$), though this difference did not reach statistical significance. Body surface area was comparable between groups (1.5 ± 0.1 kg/m² in both groups, $p = 0.937$) (Table 1). Baseline systolic pulmonary artery pressure was significantly higher in the severe pulmonary hypertension group (71.5 ± 9.8 mmHg vs.

48.3 ± 7.2 mmHg, $p < 0.001$), confirming appropriate group stratification. Significant differences were observed in functional status, with patients in the severe pulmonary hypertension group demonstrating higher NYHA functional classes ($p = 0.03$), with more patients in NYHA class III (73.7% vs. 46.2%), while the mild–moderate group had more patients in NYHA classes I and II. Echocardiographic evaluation revealed important baseline differences: patients with severe pulmonary hypertension had significantly larger left atrial diameters (56.3 ± 9.8 vs. 49.5 ± 6.7 mm, $p = 0.01$) and higher mean transvalvular pressure gradients (14.4 ± 5.3 vs. 11.3 ± 5.0 mmHg, $p = 0.025$). Interestingly, left ventricular end-diastolic diameter was smaller in the severe group (43.1 ± 7.1 vs. 49.0 ± 7.6 mm, $p = 0.003$). Left ventricular ejection fraction was similar between groups (52.5 ± 7.6% vs. 52.9 ± 8.6%, $p = 0.836$) (Table 1).

Table 1. Preoperative patient characteristics.

Variable	Mild–Moderate PH (n = 67)	Severe PH (n = 19)	p-Value
Age (years), mean ± SD	47.7 ± 9.1	44.7 ± 10.2	0.211
Male gender, n (%)	16 (23.9)	8 (42.1)	0.165
BSA (kg/m ²), mean ± SD	1.5 ± 0.1	1.5 ± 0.1	0.937
Systolic PAP (mmHg), mean ± SD	48.3 ± 7.2	71.5 ± 9.8	<0.001
NYHA Class, n (%)			0.03
• Class I	2 (3.0)	0 (0)	
• Class II	33 (49.3)	5 (26.3)	
• Class III	31 (46.2)	14 (73.7)	
• Class IV	1 (1.5)	0 (0)	
Hypertension, n (%)	1 (1.5)	0 (0)	0.597
Chest X-ray ratio (%)	58.7 ± 5.9	58.5 ± 8.3	0.903
Echocardiographic Parameters			
LVEDD (mm)	49.0 ± 7.6	43.1 ± 7.1	0.003
LA diameter (mm)	49.5 ± 6.7	56.3 ± 9.8	0.01
Peak gradient (mmHg)	22.1 ± 7.4	25.0 ± 9.3	0.155
Mean gradient (mmHg)	11.3 ± 5.0	14.4 ± 5.3	0.025
Ejection fraction (%)	52.9 ± 8.6	52.5 ± 7.6	0.836

BSA = body surface area; LA = left atrial; LVEDD = left ventricular end-diastolic diameter; NYHA = New York Heart Association; PH = pulmonary hypertension; SD = standard deviation.

3.2. Early Postoperative Outcomes

In-hospital mortality occurred in one patient (5.3%) in the severe pulmonary hypertension group compared to zero deaths in the mild–moderate group ($p = 0.221$, Fisher’s exact test). Patients with severe pulmonary hypertension demonstrated significantly longer intensive care unit stays (6.3 ± 3.7 vs. 4.7 ± 2.2 days, $p = 0.024$). However, mechanical ventilation time did not differ significantly between groups (42.8 ± 97.8 vs. 17.9 ± 25.7 h, $p = 0.287$). Reoperation for bleeding occurred in one patient in the mild–moderate group with no cases in the severe group ($p = 0.597$) (Table 2).

Table 2. Early postoperative outcomes.

Variable	Mild–Moderate PH (n = 67)	Severe PH (n = 19)	p-Value
Mechanical ventilation time (hours)	17.9 ± 25.7	42.8 ± 97.8	0.287
ICU stay (days)	4.7 ± 2.2	6.3 ± 3.7	0.024
Reoperation for bleeding, n (%)	1 (1.5)	0 (0)	0.597
In-hospital mortality, n (%)	0 (0)	1 (5.3)	0.221

ICU = intensive care unit; PH = pulmonary hypertension.

3.3. Follow-Up Results in Functional and Hemodynamic Outcomes

At the 1-month follow-up, both groups demonstrated excellent outcomes with no significant differences in any measured parameters. Systolic pulmonary artery pressure was similar (26.4 ± 3.3 vs. 26.2 ± 2.6 mmHg, $p = 0.813$), as were prosthetic valve gradients, left ventricular function, and cardiac dimensions (Table 3). This pattern of equivalent outcomes persisted at the 6-month and 12-month evaluations (Tables 4 and 5). At 12 months, systolic pulmonary artery pressures remained comparable (26.1 ± 2.7 vs. 26.5 ± 2.9 mmHg, $p = 0.584$), with no significant differences in left ventricular ejection fraction ($58.9 \pm 6.5\%$ vs. $57.5 \pm 6.8\%$, $p = 0.431$), prosthetic valve function, or cardiac dimensions between groups (Table 5). Throughout the follow-up period, both groups demonstrated sustained improvement in hemodynamic parameters. Pulmonary artery pressures decreased substantially from preoperative levels in both groups and remained stable during follow-up, as demonstrated in Tables 3–5. Left ventricular function was well-preserved in both groups, with ejection fractions maintaining or improving over time. Prosthetic valve function remained excellent with appropriate pressure gradients and no evidence of structural valve deterioration or significant regurgitation in either group.

Table 3. Follow-up results at 1 Month.

Variable	Mild–Moderate PH (n = 66)	Severe PH (n = 18)	p-Value
Systolic PAP (mmHg)	26.2 ± 2.6	26.4 ± 3.3	0.813
Peak gradient (mmHg)	9.4 ± 3.6	9.0 ± 2.8	0.639
Mean gradient (mmHg)	4.1 ± 1.5	3.8 ± 1.1	0.348
Ejection fraction (%)	54.8 ± 6.7	54.8 ± 5.4	0.993
LVEDD (mm)	46.2 ± 6.1	45.0 ± 5.5	0.464
LVESD (mm)	31.5 ± 3.5	30.9 ± 2.4	0.397
LA diameter (mm)	43.9 ± 5.6	45.4 ± 4.7	0.291

LA = left atrial; LVEDD = left ventricular end-diastolic diameter; LVESD = left ventricular end-systolic diameter; PAP = pulmonary artery pressure; PH = pulmonary hypertension.

Table 4. Follow-up results at 6 Months.

Variable	Mild–Moderate PH (n = 66)	Severe PH (n = 18)	p-Value
Systolic PAP (mmHg)	26.4 ± 2.6	27.2 ± 3.1	0.279
Peak gradient (mmHg)	9.4 ± 3.4	9.1 ± 2.0	0.629
Mean gradient (mmHg)	4.0 ± 1.4	3.9 ± 0.8	0.700
Ejection fraction (%)	55.8 ± 6.7	57.3 ± 5.2	0.388

Table 4. *Cont.*

Variable	Mild–Moderate PH (n = 66)	Severe PH (n = 18)	p-Value
LVEDD (mm)	45.2 ± 5.5	44.7 ± 5.3	0.759
LVESD (mm)	30.9 ± 3.1	31.5 ± 2.5	0.481
LA diameter (mm)	42.0 ± 5.3	44.4 ± 4.3	0.090

LA = left atrial; LVEDD = left ventricular end-diastolic diameter; LVESD = left ventricular end-systolic diameter; PAP = pulmonary artery pressure; PH = pulmonary hypertension.

Table 5. Follow-up results at 12 Months.

Variable	Mild–Moderate PH (n = 66)	Severe PH (n = 18)	p-Value
Systolic PAP (mmHg)	26.5 ± 2.9	26.1 ± 2.7	0.584
Peak gradient (mmHg)	10.1 ± 3.3	9.3 ± 2.2	0.240
Mean gradient (mmHg)	4.6 ± 1.6	4.6 ± 1.6	0.886
Ejection fraction (%)	57.5 ± 6.8	58.9 ± 6.5	0.431
LVEDD (mm)	44.7 ± 5.0	44.5 ± 4.6	0.880
LVESD (mm)	30.9 ± 3.5	30.7 ± 2.1	0.809
LA diameter (mm)	40.9 ± 4.7	41.5 ± 3.5	0.623

LA = left atrial; LVEDD = left ventricular end-diastolic diameter; LVESD = left ventricular end-systolic diameter; PAP = pulmonary artery pressure; PH = pulmonary hypertension.

4. Discussion

The present study examined outcomes following mechanical mitral valve replacement with posterior leaflet preservation in patients with severe versus mild–moderate pulmonary hypertension. Our data indicate no statistically significant difference in mortality between groups (5.3% vs. 0%, $p = 0.221$), though the limited sample size precludes definitive conclusions. The observed mortality rate in the severe pulmonary hypertension cohort is lower than rates reported in earlier studies from the 1970s, which documented mortality rates of 31–61% [5,6,8,15,16]. This reduction likely reflects improvements in surgical techniques, anesthetic management, and perioperative care that have evolved over the past five decades [2,16,17]. The significantly prolonged intensive care unit stay in the severe pulmonary hypertension group (6.3 vs. 4.7 days, $p = 0.024$) represents the primary difference in early postoperative outcomes, suggesting increased resource utilization without corresponding increases in mortality or major complications. Similar observations have been reported in meta-analyses examining pulmonary hypertension outcomes following mitral valve intervention [17,18]. Posterior leaflet preservation maintained left ventricular systolic function across both groups throughout the 12-month follow-up period, with previous studies reporting potential benefits of subvalvular apparatus preservation compared to conventional replacement techniques [15,19].

Follow-up echocardiographic parameters at 1, 6, and 12 months demonstrated no significant between-group differences in pulmonary artery pressures, left ventricular function, or prosthetic valve performance, suggesting that both patient groups achieved similar hemodynamic outcomes following surgery [20,21]. Perioperative medical management likely contributed to the observed outcomes, with standard heart failure medications administered according to established guidelines and a multidisciplinary approach incorporating cardiac surgery and internal medicine expertise optimizing patient management [22–25]. Several limitations affect the interpretation of these results, including the single-center

design, relatively small sample size (particularly in the severe pulmonary hypertension group), and 12-month follow-up duration, which limit generalizability. Additionally, the absence of a control group undergoing conventional mitral valve replacement without leaflet preservation prevents assessment of the specific contribution of this surgical technique to the observed outcomes. Longer-term follow-up would be required to assess durability and late complications in this patient population.

5. Conclusions

This prospective study of 86 patients undergoing mechanical mitral valve replacement with posterior leaflet preservation demonstrates that severe pulmonary hypertension does not significantly increase mortality or compromise long-term outcomes when contemporary surgical techniques are employed. While patients with severe pulmonary hypertension required longer ICU stays, they achieved equivalent functional and hemodynamic results compared to those with mild–moderate pulmonary hypertension. These findings challenge historical perceptions and support the safety and efficacy of modern mitral valve surgery in patients with severe pulmonary hypertension, suggesting that this condition should not be considered a contraindication to surgical intervention when appropriate expertise and techniques are available.

6. Clinical Implications

These findings have important clinical implications for patient counseling and surgical decision-making. Patients with severe pulmonary hypertension should be informed that contemporary surgical techniques have significantly improved outcomes compared to historical reports. The results support early surgical intervention in appropriate candidates rather than delaying surgery due to concerns about pulmonary hypertension. Healthcare teams should be prepared for potentially longer ICU stays in patients with severe pulmonary hypertension while recognizing that overall outcomes remain excellent with modern techniques.

7. Limitations

Several limitations should be acknowledged. The relatively small sample size, particularly in the severe pulmonary hypertension group ($n = 19$), may limit the statistical power to detect smaller differences between groups. The single-center design may affect generalizability to other institutions with different surgical expertise or patient populations. The follow-up was limited to 12 months, which may not capture late complications or durability issues. Additionally, the study did not include a comparison group undergoing conventional mitral valve replacement without leaflet preservation, which would have strengthened the evidence for this specific technique.

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Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of Hue Central Hospital (Approval Number: 2336/BVH, dated 10 January 2025). All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional

research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent was also obtained from all participating patients for the use of their anonymized data in publication.

Data Availability Statement: The datasets generated and analyzed during the current study are not publicly available due to patient privacy restrictions but are available from the corresponding author upon reasonable request and with appropriate institutional approval.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

ACC	American College of Cardiology
AHA	American Heart Association
BSA	Body Surface Area
EF	Ejection Fraction
ESC	European Society of Cardiology
ERS	European Respiratory Society
ICU	Intensive Care Unit
LA	Left Atrial
LVEDD	Left Ventricular End-Diastolic Diameter
LVESD	Left Ventricular End-Systolic Diameter
NYHA	New York Heart Association
PAP	Pulmonary Artery Pressure
PH	Pulmonary Hypertension
TEER	Transcatheter Edge-to-Edge Repair

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