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# LEFT VENTRICLE REVERSE REMODELING AFTER BARLOW MITRAL VALVE REPAIR WITH LEAFLET PRESERVATION VERSUS LEAFLET RESECTION

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## ABSTRACT

***Background:*** Left ventricular (LV) remodeling is a characteristic consequence of chronic volume overload in Barlow's disease. While mitral valve repair (MVR) is the gold standard treatment, the impact of specific surgical techniques—specifically leaflet preservation ("Respect") versus leaflet resection ("Resect")—on the subsequent process of LV reverse remodeling remains a subject of clinical debate.

***Methods:*** We conducted a study of 68 patients with Barlow's disease who successfully underwent minimally invasive MVR at University Medical Center between 2020 and 2025. Patients were evaluated using preoperative and postoperative echocardiography at discharge and 1-year follow-up to track LV morphological evolution and functional recovery.

***Results:*** A significant reverse remodeling process was observed across the cohort, with LV end-diastolic diameter (LVEDD) decreasing from 58.1 ± 5.0 mm to 47.8 ± 6.2 mm at one year ($p < 0.001$). An initial "LVEF paradox" was noted, where mean LVEF dropped from 62.3% to 53.4% at discharge before rebounding to 57.6% at 12 months. Subgroup analysis revealed that the "Respect" technique (n=37) achieved significantly higher mean LVEF at 1-year (59.1 ± 5.4%) compared to the "Resect" technique (55.9 ± 6.2%, $p = 0.018$). Furthermore, 82.6% of "top performers" (LVEF > 60%) were from the Respect group. Optimized annular downsizing (7–11 mm) was also strongly correlated with superior systolic recovery.

***Conclusions:*** Surgical repair for Barlow's disease facilitates robust LV reverse remodeling. However, a leaflet-preservation strategy ("Respect") combined with optimized annular downsizing provides superior 1-year functional outcomes compared to leaflet resection, supporting a "Respect-first" approach to maximize hemodynamic benefits.

***Keywords:*** *Barlow's disease, Mitral valve repair, Left ventricular reverse remodeling, Leaflet preservation, Neochordae.*

## 1. INTRODUCTION

Left ventricular (LV) remodeling is a common consequence of chronic volume overload in patients with degenerative mitral regurgitation (MR), such as those with Barlow's disease. This compensatory mechanism involves progressive LV dilatation and eccentric remodeling to maintain forward stroke volume despite the regurgitant flow. While mitral valve repair is the gold standard treatment to eliminate volume overload, the subsequent process of LV reverse remodeling is complex and often occurs in distinct physiological stages.

Recent evidence from randomized controlled trials, such as the CAMRA Trial CardioLink-2 [1], suggests that postoperative reverse remodeling follows a "phased process". In the early postoperative phase, there is typically a significant reduction in LV end-diastolic volume (LVEDV) due to the immediate elimination of the regurgitant fraction. However, improvements in LV end-systolic volume (LVESV) and the recovery of LV ejection fraction (LVEF)—which often drops immediately after surgery—may only become evident over a longer period, such as 12 months post-repair.

Furthermore, a key area of clinical interest is whether the specific surgical approach—specifically leaflet resection versus leaflet preservation (using neochords)—influences these remodeling trends [2]. these remodeling trends [2]. Preservation techniques are theorized to better maintain the subvalvular apparatus and annular-ventricular continuity, Some studies have confirmed the aforementioned theory in patients with posterior leaflet prolapse [3][4]. This article explores the progression of LV structural and functional changes following mitral repair for Barlow's disease, a complex mitral valve anatomy with bileaflet prolase, highlighting the expected timelines for recovery and the impact of different surgical techniques.

## 2. METHODS

### 2.1. Study population

With the approval of the Ethic Committee of the University of Medicine and Pharmacology at Ho Chi Minh city (approval number 1044/HĐĐĐ-ĐHYD), the study was conducted. The patients with documented mitral valve regurgitation with Barlow's disease who successesfully underwent minimally invasive mitral valve repair at University Medical Center between 2020 and 2025 were included in the current study. The diagnosis of Barlow disease was based upon preoperative echocardiography and confirmed by the surgeon's direct assessment during open-heart procedure. All patients with Barlow's disease had excessive leaflet tissue, annular dilatation, and bileaflet prolapse or billowing.

### 2.2. Operative techniques of minimally invasive mitral valve repair

The surgical approach for mitral valve repair is via a small right mini-thoracotomy. Cardiopulmonary bypass (CPB) was instituted via femoral arterial and venous cannulation. The aorta was cross-clamped with a Chitwood clamp and myocardial protection was achieved with mild hypothermia (32C) and antegrade delivery of Custodiol cardioplegia. The left atrium was then opened posterior to the interatrial groove, and a left atrial retractor was used to expose the mitral valve.

The following techniques were used: Ring annuloplasty, the ''loop technique'' with premeasured polytetrafluoroethylene neochordae, leaflet resection with or without sliding, annuloplasty, commissural plication, and the

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edge-to-edge (“Alfieri”) technique. Mitral valve replacement was performed in patients in whom satisfactory MV repair was not achieved or was evaluated as not technically possible during the initial assessment.

TEE was repeated post-CPB in all patients to assess the quality of the MV repair.

### 2.3. Follow-up

Clinical was 100% complete and consisted of New York Heart Association (NYHA) classification, reoperation on the MV or any other cardiac reoperation, and patient survival. The follow-up was supplemented with late echocardiographic findings predominantly supplied by institutional cardiologists. The degree of MR was classified as grade 0 (absent or trivial), 1(mild), 2 (moderate), 3 (moderate-to-severe), and 4 (severe MR).

### 2.4. Statistical analysis

Continuous variables are reported as mean standard deviation, and categoric variables are reported as percentages of group totals throughout the article. Excel program (Microsoft Corp, Redmond, Wash) and Stata version X (StataCorp, College Station, Tex) were used for statistical and survival analyses.

## 3. RESULTS

### 3.1. Baseline Patient Characteristics

The study population consisted of 68 patients with a mean age of 50.6 ± 9.8 years. There was a significant male predominance (79.4%). Most patients presented with symptomatic heart failure (NYHA Class II and III). The low mean EuroSCORE II (0.59 ± 0.15) and STS Score (0.66 ± 0.21) indicated a low-risk surgical profile.

**Table 1. Baseline Demographics and Clinical Characteristics (N = 68)**

| Characteristics | Total (n=68) | Resection (n=31) | Respect (n=37) | p |
|---|---|---|---|---|
| Age (years), Mean ± SD | 50.6 ± 9.8 | 47.9 ± 10.2 | 50.5 ± 10.0 | 0.293 |
| Male Gender, n (%) | 54 (79.4%) | 24 (77,4%) | 30 (81,1%) | 0,769 |
| **NYHA Class, n (%)** | | | | |
| Class II | 38 (55.9%) | 18 (58.1%) | 20 (54.1%) | 0.485 |
| Class III | 29 (42.6%) | 12 (38.7%) | 17 (45.9%) | |
| Class IV | 1 (1.5%) | 1 (3.2%) | 0 (0%) | |
| **Comorbidities, n (%)** | | | | |
| Hypertension | 16 (23.5%) | 6 (19.4%) | 10 (27%) | 1 |
| Dyslipidemia | 15 (22.1%) | 6 (19.4%) | 9 (24.3%) | 0.77 |
| Atrial Fibrillation | 8(5.9%) | 4 (12.9%) | 4 (10.8%) | 0.53 |
| Diabetes Mellitus Type 2 | 4 (5.9%) | 2 (6.5%) | 2 (5.4%) | 1 |
| **Surgical Risk Scores, Mean ± SD** | | | | |
| EuroSCORE II (%) | 0.59 ± 0.15 | 0.59 ± 0.15 | 0.58 ± 0.14 | 0.85 |
| STS Score (%) | 0.66 ± 0.21 | 0.69 ± 0.20 | 0.63 ± 0.22 | 0.215 |
| **Echocardiography characteristics** | | | | |
| Mitral annulus | | 42.67 ± 4.15 | 42.21 ± 4.13 | 0.65 |
| Number of prolapse segment | | 2.61 ± 1.45 | 2.68 ± 1.47 | 0.86 |
| Calcification mitral valve | | 0 (0%) | 0 ( 0%) | NS |

### 3.2. Left Ventricular Morphological Evolution and Reverse Remodeling

A significant reverse remodeling process was observed postoperatively. The LVEDD decreased significantly from 58.1 ± 5.0 mm at baseline to 47.8 ± 6.2 mm at the 1-year follow-up ($p < 0.001$). Similarly, the LVEDV showed a mean reduction of 55.0 mL over the same period.

**Table 2. Echocardiographic Outcomes Over Time**

| Parameters | | | |
|---|---|---|---|
| **Pre-operative** | **Discharge** | **1-Year Follow-up** | **p-value** |
| **LVEDD (mm)** | | | |
| 58.1 ± 5.0 | 51.2 ± 4.8 | 47.8 ± 6.2 | p < 0.001 |
| **LVESD (mm)** | | | |
| 36.0 ± 4.5 | 34.2 ± 5.4 | 34.1 ± 5.1 | p < 0.002 |
| **LVEDV (mL)** | | | |
| 167.7 ±39.5 | 113.4 ±30.4 | 112.7 ±28.5 | p < 0.001 |
| **LVEF (%)** | | | |
| 62.3 ± 4.1 | 53.4 ± 6.7 | 57.6 ± 5.9 | p < 0.001 |

### 3.3. Comparative Analysis of Repair Techniques: Respect vs. Resect

The Respect technique (neochordal replacement) demonstrated superior preservation of left ventricular systolic function compared to the Resect technique. At the 1-year follow-up, the Respect group achieved a significantly higher mean LVEF (59.1± 5.4%) compared to the Resect group (55.9± 6.2%, $p = 0.018$).

**Table 3. Subgroup Analysis by Surgical Technique at 1-Year Follow-up**

| Parameters | | |
|---|---|---|
| **Resection (n=31)** | **Respect (n=37)** | **p-value** |
| **LVEDD (mm)** | | |
| 49.3 ± 5.5 | 47.0 ± 6.1 | 0.099 |
| **LVEDV (mL)** | | |
| 112.9 ± 31.2 | 112.5 ± 26.8 | 0.940 |
| **LVEF (%)** | | |
| 55.9 ± 6.2 | 59.1 ± 5.4 | 0.018 |

## 4. DISCUSSION

The surgical management of Barlow's disease remains one of the most technically demanding areas of mitral valve repair due to multisegment involvement, excess leaflet tissue, and severe annular dilation. Our study of 68 patients provides robust evidence that both "Respect" and "Resect" techniques facilitate significant left ventricular (LV) reverse remodeling within the first year. However, the data reveals a superior functional recovery profile in patients undergoing leaflet preservation .

### 4.1. Dynamics of Left Ventricular Reverse Remodeling

Our findings demonstrate a profound reduction in LV dimensions, with LVEDD decreasing from 58.1 ± 5.0 mm to 47.8 ± 6.2 mm at 12 months. This 17.7% reduction is consistent with the classic study by Castillo et al.[5], which observed that expert repair of Barlow's valves leads to a rapid return of LV size to near-normal ranges.

Crucially, our study highlights the "Phased Process" of recovery. The acute drop in LVEDD

observed predischarge reflects the immediate relief of volume overload, while the subsequent stabilization at 1-year indicates a biological adaptation of the myocardium. This mirrors the CAMRA Trial (CardioLink-2) [1] findings, where the most significant volumetric changes occurred early, followed by a slower refinement of systolic geometry. Our Figure 1 clearly illustrates this sharp initial decline followed by a plateau, reinforcing the success of the repair in resetting LV hemodynamics.

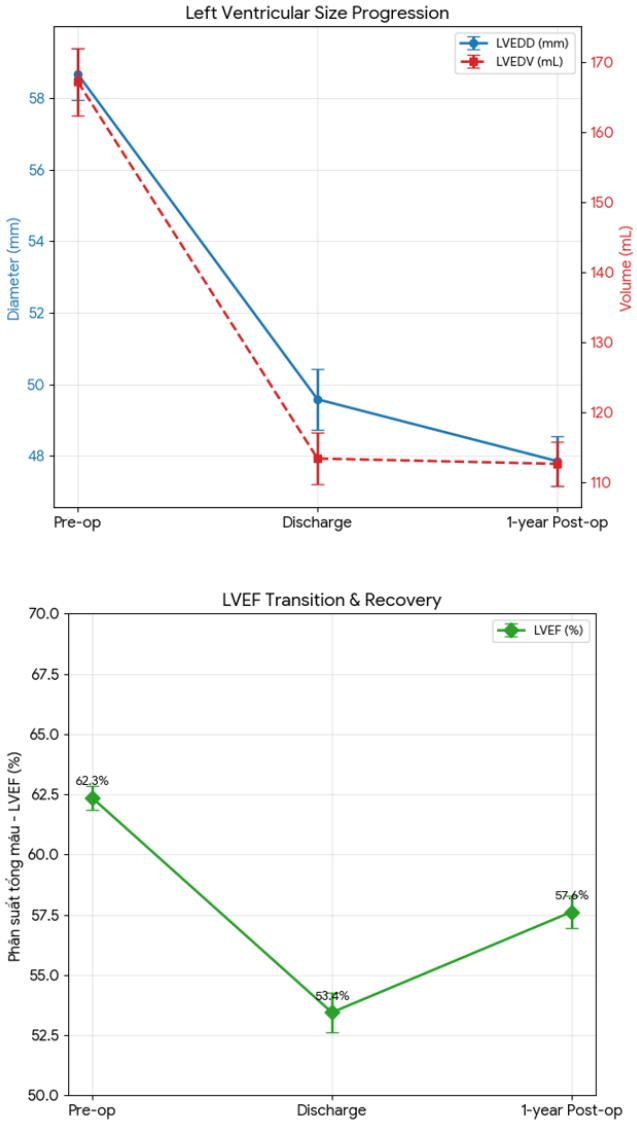


**Figure 1. Trends in Left Ventricular Morphological Evolution and Functional Recovery Over 1 Year**

### 4.2. The paradox and recovery of Left Ventricular Ejection Fraction (LVEF)

A consistent finding in our study is the acute decline in LVEF immediately following surgery (from 62.3 ± 4.1% to 53.4 ± 6.7% at discharge). This phenomenon, often referred to as the "postoperative LVEF paradox," is well-documented in degenerative mitral regurgitation (MR). In the preoperative state of Barlow's disease, the LVEF is often "supra-normal" or inflated because the left ventricle ejects into a low-resistance, high-compliance left atrium.

Once the repair eliminates the regurgitant flow, the LV must suddenly contend with a significantly higher afterload (the systemic vascular resistance). The early drop in LVEF observed in our cohort represents the unmasking of the true underlying myocardial contractile state after the removal of the "low-pressure escape" through the mitral valve. This trend is identical to the CAMRA Trial [1], which reported an early decline from 61.1 to 51.7%.

#### *Longitudinal Recovery of Systolic Function*

The long-term value of mitral repair is demonstrated by the gradual recovery of LVEF during the first year. In our study, LVEF rebounded to 57.6 ± 5.9% by 12 months. This recovery indicates positive reverse remodeling, where the reduction in volume overload allows the myocytes to regain contractile efficiency over time.

Our data supports the "Phased Process" model proposed by Le Tourneau et al.[6], which suggests that while the initial phase is dominated by preload reduction, the second phase (from discharge to 1 year) is characterized by an improvement in intrinsic systolic function. The fact that our cohort's LVEF at 1 year remained slightly lower than the baseline (57.6% vs. 62.3%) is a common finding in global literature, suggesting that some degree of chronic volume-overload induced myocardial damage may be irreversible.

### 4.3. The superiority of the "Respect" philosophy in Barlow's Disease

The most striking result of our study is the significant difference in 1-year LVEF between the two groups (59.1±5.4%in Respect vs. 55.9± 6.2% in Resect, p = 0.018). While the CAMRA Trial [1] reported no such difference in a general posterior leaflet prolapse population, our Barlow-specific cohort suggests that preservation matters more in complex pathologies.

This functional advantage can be explained by the preservation of the subvalvular apparatus. As noted by David et al. [2] in their long-term follow-up of the "Respect" technique, keeping the natural leaflet-chordal-papillary muscle continuity acts as a "frame" for the LV, preventing the spherical deformation often seen after extensive tissue resection. Our Figure 2 highlights that 82.6% of "top performers" (LVEF 1 year > 60%) came from the Respect group, providing strong clinical evidence that avoiding resection preserves the mechanical efficiency of the left ventricle better than the "Resect" approach in the setting of Barlow's disease.

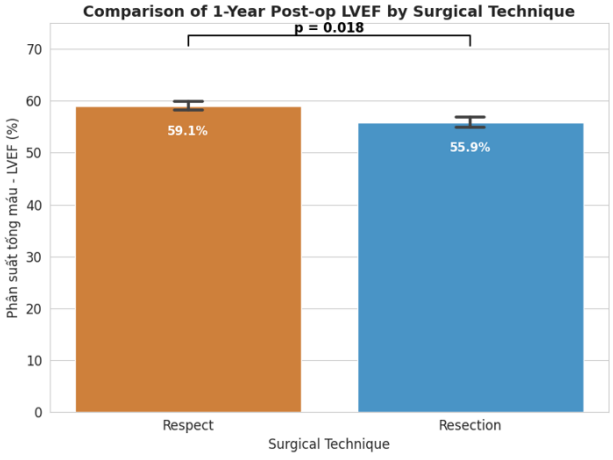


**Figure 2. Comparison of Postoperative Systolic Function: Respect vs. Resect Techniques.**

#### *Limitations and Future Directions*

Despite the significant findings, the 1-year follow-up is still an early window into the life-long journey of a repaired Barlow valve. Further investigation into Global Longitudinal Strain (GLS), as performed in recent studies by Esposito et al.[8], would be beneficial to detect subtle differences in myocardial work that LVEF might overlook.

## 5. CONCLUSION

In conclusion, surgical repair of Barlow's disease provides excellent 1-year outcomes in terms of LV reverse remodeling . Mitral valve repair using a leaflet-preservation strategy and optimized annular downsizing provides superior 1-year LV functional outcomes in patients with Barlow's disease. These findings advocate for a "Respect-first" approach to maximize the long-term hemodynamic benefits of surgery.

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