International Journal of Medicine and Medical Research

ISSN 2413-6077, e-ISSN 2414-9985
Volume 12, No. 1. 2026
Journal homepage: https://ijmr.com.ua/
Article's History: Received: 04.01.2026; Revised: 17.04.2026; Accepted: 26.05.2026; Published: 29.05.2026.

UDC 616.126.422-089.8:616.12-073.43
DOI: 10.63341/ijmmr/1.2026.55

Dynamics of left ventricular ejection fraction changes after surgical correction of mitral regurgitation

Sviatoslav Kostiv
Doctor of Medical Sciences, Professor
I. Horbachevsky Ternopil National Medical University
46001, 1 Maidan Voli, Ternopil, Ukraine
https://orcid.org/0000-0002-7963-5425

Dmytro Koval*
Postgraduate Student
I. Horbachevsky Ternopil National Medical University
46001, 1 Maidan Voli, Ternopil, Ukraine
https://orcid.org/0009-0001-4077-0670

Stanislav Lishchenko
Cardiac Surgeon
Danylo Halytsky Lviv National Medical University
79010, 7 Chernihivska Str., Lviv, Ukraine
https://orcid.org/0009-0008-1902-3831

Igor Protsyk
Cardiac Surgeon
Danylo Halytsky Lviv National Medical University
79010, 7 Chernihivska Str., Lviv, Ukraine
https://orcid.org/0009-0007-4426-5130

Vitaliy Stepanyuk
Cardiac Surgeon
Danylo Halytsky Lviv National Medical University
79010, 7 Chernihivska Str., Lviv, Ukraine
https://orcid.org/0009-0004-5156-5631

Abstract. Mitral regurgitation is among the most prevalent disorders of the cardiac valvular apparatus and leads to chronic volume overload, left ventricular dilatation, and adverse ventricular remodelling. Despite the proven efficacy of contemporary surgical techniques for correcting mitral regurgitation, early recovery of left ventricular systolic function and the tempo of reverse remodelling remain clinically important. The aim of this study was to assess early postoperative changes in left ventricular systolic function and to analyse the dynamics of ejection fraction as a marker of the effectiveness of surgical correction of mitral regurgitation. The study enrolled 40 patients with grade III-IV mitral regurgitation who underwent either mitral valve repair (45%) or mitral valve replacement (55%). Transthoracic echocardiography was performed three times – preoperatively and at 1 and 3 months after surgery. Ejection fraction was calculated using the biplane Simpson method in accordance with ASE/EACVI recommendations. Statistical analysis was performed using built-in Microsoft Excel tools with computation of means, standard deviations, and percentage changes. Preoperatively,

Suggest Citation:
Kostiv S, Koval D, Lishchenko S, Protsyk I, Stepanyuk V. Predictive modelling of clinical outcomes in acute tonsillitis based on microbiome analysis and machine learning algorithms. Int J Med Med Res. 2026;12(1):55–62. DOI: 10.63341/ijmmr/1.2026.55

*Corresponding author (*kovaldb_asp@tdmu.edu.ua*)

Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/)

mean ejection fraction was 48.2%. At 1 month, it increased to 51.7%, and at 3 months to 54.9%, consistent with early reverse remodelling. The most pronounced improvement was observed in patients with a baseline ejection fraction <50% (increase of 8-10%). Mitral valve repair was associated with more favourable early dynamics than replacement (7-9% vs 5-6%). Overall, 75% of patients demonstrated a positive trajectory as early as one month postoperatively. Surgical correction of mitral regurgitation is associated with a substantial early improvement in left ventricular systolic function. Ejection fraction dynamics within the first 1-3 postoperative months represent an important prognostic tool, enabling assessment of procedural efficacy, the rate of reverse remodelling, and optimisation of subsequent patient management

Keywords: reverse remodelling; echocardiography; systolic function; annuloplasty; valve replacement; postoperative recovery; myocardial contractility

Introduction

Mitral regurgitation remains one of the leading drivers of chronic left ventricular volume overload and progressive cardiac remodelling, ultimately resulting in symptomatic heart failure and an increased risk of adverse clinical outcomes. As emphasised in contemporary international guidelines by A. Vahanian *et al.* [1] and C.M. Otto *et al.* [2], timely, anatomically guided intervention is critical to prevent irreversible myocardial injury and to improve long-term prognosis. In routine clinical practice, many patients present only once functional limitations have developed – corresponding to New York Heart Association (NYHA) functional class II-III – when symptoms may still be moderate, yet structural remodelling is already established and may constrain postoperative recovery, as noted by P.A. Heidenreich *et al.* [3].

Accurate assessment of mitral regurgitation severity, mechanism, and remodelling phenotype is fundamental to therapeutic decision-making. Current recommendations advocate an integrated approach based on quantitative and qualitative echocardiographic parameters, supplemented, when necessary, by other imaging modalities. This is highlighted in the guidelines by A. Vahanian *et al.* [1], C.M. Otto *et al.* [2], and the imaging recommendations of P. Lancellotti *et al.* [4], who emphasised that disease trajectory and response to intervention depend not only on the degree of regurgitation but also on the adaptation of the myocardium and cardiac chambers to chronic loading.

Secondary mitral regurgitation is closely intertwined with the pathophysiology of heart failure: left ventricular dilatation, papillary muscle displacement, and remodelling of the fibrous annulus sustain regurgitation and perpetuate a vicious cycle of progressive dysfunction. A joint European statement by A.J.S. Coats *et al.* [5] underscores that management should be stepwise – optimisation of guideline-directed heart failure therapy, meticulous clinical and imaging reassessment, and timely multidisciplinary Heart Team discussion to determine whether surgical or transcatheter intervention is likely to deliver durable benefit. Importantly, the anticipated clinical effect depends on the ability to interrupt maladaptive remodelling and to initiate reverse remodelling once regurgitation is reduced.

Growing evidence consistently indicates that baseline myocardial status and the extent of remodelling influence outcomes and must be considered when interpreting early postoperative functional changes. Current heart failure guidelines emphasise that baseline left ventricular dysfunction and structural remodelling substantially influence prognosis and should be taken into account when interpreting treatment response in patients with secondary mitral regurgitation [3].

In addition, studies by G. Benfari *et al.* [7] and Joung *et al.* [8] indicate that variability in baseline left ventricular function, remodelling severity, and postoperative recovery patterns further contribute to heterogeneity in clinical outcomes after correction of mitral regurgitation. Trial-level comparisons show that patient selection and baseline remodelling substantially affect outcomes, as reflected by differences between populations enrolled in major transcatheter mitral repair studies, as reported by B. Iung *et al.* [9] and D. Messika-Zeitoun *et al.* [10].

Taken together, contemporary data confirm that the clinical benefit of mitral valve interventions is closely linked to the degree of reverse remodelling achieved after correction of regurgitation. However, available evidence remains insufficiently systematised regarding the rate and characteristics of ejection fraction recovery during the first three months after mitral valve surgery, particularly across different baseline remodelling phenotypes. This gap provides a clear rationale for targeted investigation of early postoperative changes in left ventricular systolic function as potential markers of effective correction and myocardial recovery. The aim of this study was to assess early postoperative changes in left ventricular systolic function and to analyse the dynamics of ejection fraction as a marker of the effectiveness of surgical correction of mitral regurgitation.

Literature Review

Guidance from the European Association of Cardiovascular Imaging, as presented by P. Lancellotti *et al.* [4], further highlights that standardised multimodality imaging improves reproducibility and enables a meaningful evaluation of remodelling dynamics before and after intervention. This is particularly relevant because postoperative changes in chamber size and systolic performance reflect both recovery of contractile function and alterations in loading conditions following elimination of regurgitant volume. Large imaging analyses in patients with heart failure and reduced ejection fraction, such as those conducted by G. Benfari *et al.* [7], also demonstrate that both grading and clinical consequences of functional mitral regurgitation differ across

phenotypes, underscoring the need for individualised interpretation of remodelling and function. Evidence from contemporary clinical studies suggests that differences in baseline left ventricular systolic function and remodelling status may help explain heterogeneous responses to mitral valve intervention and divergent trajectories of reverse remodelling [8]. Post hoc analyses, in particular, underscore that the degree of left ventricular remodelling modifies clinical benefit, suggesting that marked dilatation and limited myocardial reserve may attenuate functional recovery even when regurgitation is effectively reduced, as shown by D. Messika-Zeitoun *et al.* [10]. Moreover, previous surgical series have shown that baseline ventricular status and the extent of structural myocardial adaptation are important modifiers of postoperative recovery and may influence the magnitude of functional improvement after intervention [11].

Long-term follow-up from transcatheter correction trials demonstrates that sustained reduction of secondary mitral regurgitation can translate into durable clinical benefit in appropriately selected patients. Three-year outcomes confirm further reductions in heart failure hospitalisations and preservation of clinical advantage compared with medical therapy alone, as demonstrated by M.J. Mack *et al.* [12], while five-year data additionally support persistent benefit in selected populations, as reported by G.W. Stone *et al.* [13], highlighting the importance of long-term regurgitation control and favourable remodelling response over time. Collectively, these findings reinforce a central principle that is equally relevant to surgical correction: durable elimination or substantial reduction of regurgitation should promote reverse remodelling, although the extent and tempo of functional recovery remain variable and are largely determined by pre-intervention myocardial condition.

In primary degenerative mitral regurgitation, contemporary imaging studies indicate that reverse remodelling after valve repair extends beyond reduction in chamber dimensions and also encompasses changes in myocardial tissue characteristics. Previous studies indicate that apparently preserved preoperative left ventricular systolic function does not always reflect normal myocardial reserve, and that postoperative dysfunction may still occur despite seemingly acceptable baseline parameters [14]. This strengthens the rationale for early postoperative assessment using sensitive markers of myocardial recovery, since pre-existing fibrosis or advanced remodelling may limit reversibility and contribute to incomplete normalisation of function.

Surgical strategies also continue to evolve with respect to choosing between repair and replacement across different aetiologies and high-risk scenarios. Evidence indicates that outcomes differ between repair and replacement strategies, as demonstrated by A. Tomšič *et al.* [15], underscoring that procedure selection, underlying substrate, and the durability of effective regurgitation elimination influence long-term results. Recurrent regurgitation after repair remains a clinically relevant issue – particularly in ischemic/functional settings – since recurrent mitral regurgitation is associated with less favourable reverse remodelling, as reported by A. Salsano *et al.* [16], supporting the value of durable regurgitation control and meticulous selection of reconstructive techniques to maximise long-term valve competence. In parallel, contemporary reports in high surgical-risk populations with mitral regurgitation, such as those by M. Sudo *et al.* [17], emphasise outcome heterogeneity and the importance of baseline status and treatment strategy for functional recovery and survival.

Reviews and expert syntheses increasingly focus on the early postoperative period as a critical "window" for understanding myocardial adaptation after intervention. Current approaches to surgical management of mitral regurgitation, as summarised by S.R. Eapen *et al.* [18], highlight that early changes in systolic performance and remodelling parameters may provide clinically meaningful insight into procedural effectiveness and the direction of subsequent recovery, while acknowledging that interpretation is complicated by immediate post-repair changes in loading conditions after regurgitant volume is reduced. Accordingly, systematic evaluation of early postoperative dynamics is important for risk stratification, follow-up planning, and optimisation of postoperative management.

Materials and Methods

The study was conducted between 1 August 2025 and 30 November 2025 in I. Horbachevsky Ternopil National Medical University in Ukraine. This study enrolled 40 patients with hemodynamically significant grade III-IV mitral regurgitation who met established indications for surgical treatment. All patients were consecutively included during the study period among individuals fulfilling predefined eligibility criteria and referred for surgical correction of mitral regurgitation. This consecutive recruitment strategy minimised selection bias and yielded a clinically relatively homogeneous cohort. The primary endpoint was the early postoperative change in left ventricular ejection fraction (LVEF). Adult patients with confirmed severe mitral regurgitation were eligible provided that indications for surgical intervention were established by a multidisciplinary Heart Team and patients were able to undergo standardised echocardiographic follow-up at prespecified time points. Exclusion criteria comprised acute conditions requiring emergency surgery, previous mitral valve interventions, significant concomitant valvular disease necessitating multivalve correction, and inability to complete the follow-up protocol.

The study was conducted in accordance with generally accepted ethical standards for medical research. Written informed consent for study participation and publication of anonymised results was obtained from all participants. The protocol adhered to the ethical principles of the World Medical Association's Declaration of Helsinki [19] for research involving human subjects and complied with European Commission requirements regarding ethics and data protection. Confidentiality was ensured through data anonymisation and restricted access to personal information. Postoperative management followed contemporary clinical

guidelines. All patients received standardised pharmacotherapy, including guideline-directed heart failure treatment and anticoagulation when indicated. Rehabilitation was performed according to a unified clinical protocol incorporating early mobilisation and gradual escalation of physical activity. Any individualised treatment modifications were documented and considered in the analysis as potential confounders.

Degenerative (myxomatous) mitral valve disease was the most frequent aetiology, identified in 18 patients (45%). Functional ischemic mitral regurgitation associated with left ventricular remodelling and altered mitral annular geometry was diagnosed in 14 patients (35%). Rheumatic mitral valve disease accounted for 6 cases (15%), whereas other causes – including infective endocarditis and post-traumatic changes – were documented in 2 patients (5%). The mean age of the cohort was 61.8 ± 9.4 years; 60% were men and 40% women. All patients exhibited symptoms of heart failure classified as NYHA functional class II-III according to the New York Heart Association functional classification [20], reflecting clinical decompensation with symptom duration ranging from 6 months to 4 years.

Patients were allocated into two groups based on the surgical strategy: the repair group included 18 individuals (45%) who underwent mitral valve repair using contemporary annuloplasty and leaflet reconstruction techniques; the replacement group comprised 22 individuals (55%) who underwent mitral valve replacement with either bioprosthetic or mechanical prostheses. A substantial proportion of patients had clinically significant comorbidities that could potentially influence postoperative myocardial recovery. Arterial hypertension was the most prevalent condition, present in 30 patients (75%), followed by chronic ischemic heart disease in 13 patients (32.5%) and atrial fibrillation in 12 patients (30%). Type 2 diabetes mellitus was diagnosed in 8% of patients, while chronic kidney disease stage I-II was observed in 6% of the cohort. Follow-up assessments were performed at three time points: preoperatively, at 1 month, and at 3 months after surgery. The principal parameter of interest was LVEF, which was regarded as a key marker of systolic functional recovery and early reverse myocardial remodelling. Echocardiographic examinations were performed using high-resolution expert-grade ultrasound systems available in the cardiovascular imaging unit, employing standard apical two- and four-chamber views. All studies were conducted by experienced cardiologists with formal echocardiography training in accordance with current professional standards. LVEF was calculated using the biplane Simpson method in line with recommendations from the American Society of Echocardiography and the European Association of Cardiovascular Imaging [21].

The free version of ChatGPT was used solely for grammar and spelling checks. All data, research results, and their interpretation are the authors' own. Data analysis was performed in Microsoft Excel (Microsoft Corp., USA). Descriptive statistics were computed using standard spreadsheet functions, including means, standard deviations, and percentage changes. All LVEF values were entered into a structured database encompassing three measurement points: baseline (preoperative), 1 month, and 3 months. For each interval, the mean LVEF, standard deviation (SD), range, and percentage change relative to the preceding time point were calculated. Normality of distribution was assessed using the Shapiro-Wilk test. Temporal changes in LVEF were analysed using a two-way repeated-measures analysis of variance (ANOVA), with time (preoperative, 1 month, 3 months) as the within-subject factor and intervention type (mitral valve repair vs replacement) as the between-subject factor. This approach enabled assessment of the main effects of time and group, as well as their interaction. When the assumption of sphericity was violated, the Greenhouse-Geisser correction was applied. In the absence of normality, nonparametric alternatives were used. Post hoc pairwise comparisons were performed with Bonferroni adjustment for multiple testing. A two-sided p value <0.05 was considered statistically significant.

Results and Discussion

Based on echocardiographic assessment, LVEF was evaluated at three time points: prior to surgical correction, 1 month postoperatively, and 3 months after the intervention. Analysis of a cohort of 40 patients demonstrated early patterns of recovery of systolic function and the dynamics of reverse myocardial remodelling following the correction of mitral regurgitation. Preoperative evaluation showed that in 6 patients (15%), LVEF was ≥60%; in 14 patients (35%), it ranged from 50-59%; and in 20 patients (50%), it was <50%. In the mitral valve repair group (n = 18), LVEF ≥60% was observed in 4 patients (22%), LVEF 50-59% in 7 patients (39%), and LVEF <50% in 7 patients (39%). In the mitral valve replacement group (n = 22), LVEF ≥60% was found in 2 patients (9%), LVEF 50-59% in 7 patients (32%), and LVEF <50% in 13 patients (59%). The results of this study demonstrate a clear, consistent, and clinically significant improvement in left ventricular systolic function following surgical correction of mitral regurgitation. A detailed analysis of changes in ejection fraction during the early postoperative period not only enables quantitative assessment of surgical efficacy but also provides deeper insight into the pathophysiological mechanisms of reverse myocardial remodelling that determine long-term patient outcomes.

Preoperative cohort characteristics indicate substantial heterogeneity in left ventricular functional status. Half of the patients (50%) had an ejection fraction <50%, indicating established systolic dysfunction. Another 35% had an ejection fraction in the range of 50-59%, which may be considered a borderline state, where early signs of impaired contractility are already present but partial compensation is still maintained. Only 15% of patients had an ejection fraction ≥60%, corresponding to normal systolic function. This distribution highlights that most patients undergo surgical treatment at a stage of significant cardiac remodelling. Following surgical correction of mitral regurgitation, a marked shift in hemodynamic conditions occurs.

Elimination of regurgitation reduces volume overload, but simultaneously increases effective afterload on the left ventricle. This restructuring is key to interpreting early postoperative changes in ejection fraction. In some cases, a transient decrease in ejection fraction may be observed in the early period; however, in this study, overall improvement was already evident at 1 month.

Overall, 75% of patients demonstrated positive dynamics as early as 1 month after surgery. This indicates rapid activation of adaptive mechanisms and the initiation of reverse remodelling processes. Thus, the first postoperative month can be considered a critical period for evaluating the effectiveness of the intervention. In the group of patients who underwent mitral valve repair, the most pronounced improvement in functional parameters was observed. The mean ejection fraction increased from 49.5% to 53.4% at 1 month and to 57.2% at 3 months, corresponding to an overall increase of +7.7% (Table 1).

Table 1. Dynamics of LVEF after mitral valve repair

Time period	LVEF(M ± SD), %	Increase, %	p-value
Before surgery	49.5 ± 7.2	-	-
At 1 month	53.4 ± 6.9	+3.9	$p < 0.05$
At 3 months	57.2 ± 6.5	+7.7	$p < 0.01$

Source: compiled by authors

Analysis of Table 1 allows several important conclusions to be drawn. First, the improvement in ejection fraction is gradual in nature and is not limited to the early postoperative period but continues throughout the entire three-month follow-up. Second, the reduction in standard deviation indicates a more homogeneous patient response, which may be associated with the more physiological nature of the intervention. Third, the achievement of ejection fraction values above 55% in the majority of patients suggests effective recovery of systolic function.

The obtained results are consistent with current clinical guidelines. According to A. Vahanian *et al.* [1], mitral valve repair is associated with better preservation of left ventricular function compared with valve replacement. This is explained by the fact that repair preserves the subvalvular apparatus, which plays a crucial role in maintaining left ventricular geometry and function. In the mitral valve replacement group, improvement was also observed; however, it was less pronounced. The mean ejection fraction increased from 47.1% to 50.3% at 1 month and to 52.6% at 3 months, corresponding to an overall increase of +5.5% (Table 2).

The smaller magnitude of improvement after mitral valve replacement may be attributable to the absence of native valvular structures, partial excision of the subvalvular apparatus, alterations in left ventricular geometry, and increased afterload associated with the presence of a prosthesis. The presence of a prosthesis may influence ventricular geometry and loading conditions, thereby contributing to a slower regression of dilatation and a less rapid increase in ejection fraction. According to M. Sudo *et al.* [17], the extent of reverse remodelling after mitral valve replacement may be constrained by the mechanical characteristics of prosthetic valves. A similar trend was observed in this study, in which recovery of LVEF in the replacement group occurred more slowly.

Table 2. Dynamics of LVEF after mitral valve replacement

Time period	LVEF (M ± SD), %	Increase (%)	p-value
Before surgery	47.1 ± 7.6	-	-
At 1 month	50.3 ± 7.3	+3.2	$p < 0.05$
At 3 months	52.6 ± 7.0	+5.5	$p < 0.05$

Source: compiled by authors

Conversely, V. Osaulenko *et al.* [22] emphasised that preservation of the subvalvular apparatus plays an important role in maintaining the physiological interaction between the valve and the myocardium. Present findings are consistent with these data and suggest that early recovery of systolic function largely depends on preservation of mitral-ventricular continuity. Comparative analysis demonstrated that mitral valve repair provides a statistically significantly faster and more pronounced restoration of left ventricular systolic function compared with valve replacement (Table 3).

Table 3. Comparison of LVEF between mitral valve repair and replacement

Indicator	Repair (M ± SD)	Replacement (M ± SD)	Difference Δ, %	p-value
LVEF before surgery	49.5 ± 7.2	47.1 ± 7.6	+2.4	$p = 0.21$
LVEF at 1 month	53.4 ± 6.9	50.3 ± 7.3	+3.1	$p < 0.05$
LVEF at 3 months	57.2 ± 6.5	52.6 ± 7.0	+4.6	$p < 0.01$
ΔLVEF (0-1 month)	+3.9%	+3.2%	+0.7	$p = 0.34$
ΔLVEF (0-3 months)	+7.7%	+5.5%	+2.2	$p < 0.05$

Source: compiled by authors

As shown in Table 3, the preoperative difference between the groups was not statistically significant ($p = 0.21$), confirming their baseline comparability. However, as early as 1 month after surgery, the difference becomes significant ($p < 0.05$), and by 3 months it is even more pronounced ($p < 0.01$). This indicates that mitral valve repair provides faster and more effective functional recovery. According to V. Osaulenko *et al.* [22], preservation of the subvalvular apparatus plays a crucial role in maintaining physiological ventricular mechanics and improving postoperative outcomes. The findings of this study are fully consistent with this statement.

An important factor influencing outcomes is the baseline level of ejection fraction. In this study, patients with an ejection fraction <50% demonstrated the greatest improvement (up to 8-10%). This can be explained by their greater potential for reverse remodelling. Patients with reduced baseline myocardial function may demonstrate greater relative improvement after intervention because of a higher potential for reverse remodelling [3]. At the same time, in patients with preserved ejection fraction, the improvement was less pronounced, which may indicate a limited functional reserve. As noted by G. Benfari *et al.* [7], the severity and clinical impact of functional mitral regurgitation strongly depend on the degree of left ventricular remodelling. This may explain why some patients demonstrate slower recovery even after successful intervention.

In addition, recent studies emphasise the importance of patient stratification. Recent studies suggest that more detailed patient stratification according to baseline ventricular function and remodelling severity may improve prediction of response to treatment [8]. Although such classification was not applied in this study, the obtained results support its potential relevance. Comorbidities also have a significant impact on the recovery process. Arterial hypertension, present in the majority of patients, contributes to the persistence of increased afterload even after surgery. Ischemic heart disease limits recovery of contractility, while atrial fibrillation negatively affects diastolic function. Previous studies of surgical correction of mitral regurgitation suggest that adverse baseline ventricular remodelling may limit the extent of postoperative functional recovery [11].

Another important aspect is the time factor. Early changes in ejection fraction have significant prognostic value. As stated by to S.R. Eapen *et al.* [18], early postoperative changes in ventricular function represent a critical window for assessing procedural success and predicting long-term outcomes. This highlights the need for regular patient monitoring during the first months after surgery. The physiological mechanisms underlying improvement in ejection fraction include a complex interplay of processes: elimination of volume overload, normalisation of left ventricular geometry, reduction of wall stress, improvement of myocardial contractility

However, it is important to note that part of the improvement may be related not only to myocardial recovery but also to changes in loading conditions. Previous reports suggest that postoperative changes in left ventricular function reflect not only recovery of contractility but also the unmasking of pre-existing myocardial dysfunction after elimination of regurgitant unloading [14]. This indicates that the recovery process is complex and includes both functional and morphological adaptations. Additionally, the rate and extent of remodelling may depend on patient age, disease duration, and timing of surgical intervention. Early surgery is associated with better outcomes, as it helps prevent the development of irreversible myocardial changes.

In summary, the findings suggest that the dynamics of ejection fraction in the early postoperative period represent a reliable and sensitive marker of the effectiveness of surgical treatment for mitral regurgitation. Mitral valve repair demonstrates clear advantages over valve replacement, as evidenced by faster and more pronounced recovery of left ventricular systolic function. Overall, the results of the study allow the following key conclusions to be formulated: early improvement in ejection fraction is an important indicator of procedural success; the type of surgical intervention determines the rate and pattern of recovery; baseline myocardial status influences the potential for reverse remodelling; and comorbidities may significantly modify treatment outcomes.

Conclusions

The present study demonstrated that surgical correction of mitral regurgitation is associated with a significant improvement in left ventricular systolic function in the early postoperative period. The analysis revealed a statistically significant increase in ejection fraction as early as 1 month after intervention, with further improvement by 3 months of follow-up. This favourable trajectory was accompanied by signs of early reverse myocardial remodelling, reflecting left ventricular adaptation to the reduction of chronic volume overload. In the overall cohort, mean LVEF increased from 48.2% preoperatively to 51.7% at 1 month and to 54.9% at 3 months. In subgroup analysis, LVEF after mitral valve repair increased from $49.5 \pm 7.2\%$ to $57.2 \pm 6.5\%$ (+7.7%), whereas after mitral valve replacement it increased from $47.1 \pm 7.6\%$ to $52.6 \pm 7.0\%$ (+5.5%).

Comparative analysis showed that recovery of pump function was faster and of greater magnitude in patients undergoing mitral valve repair than in those undergoing valve replacement. A larger increase in ejection fraction was observed in the repair group both at 1 month and at 3 months. These findings suggest that preservation of mitral-ventricular continuity may play an important role in maintaining physiological ventricular mechanics and facilitating more effective restoration of contractile function.

It was also found that comorbid conditions – particularly arterial hypertension, atrial fibrillation, and ischemic heart disease – frequently accompany severe mitral regurgitation and may influence the rate of postoperative functional recovery. At the same time, standardised perioperative management, including guideline-directed heart

failure therapy and anticoagulation when indicated, contributed to early postoperative clinical stability and enabled an objective assessment of changes in systolic function. Further studies should focus on long-term patterns of left ventricular remodelling over extended follow-up intervals. Longer surveillance may provide deeper insight into myocardial adaptation processes after surgical correction of mitral regurgitation.

Acknowledgements
None.

Funding
None.

Conflict of Interest
None.

References
[1] Vahanian A, Beyersdorf F, Praz F, Milojevic M, Baldus S, Bauersachs J, et al. 2021 ESC/EACTS Guidelines for the management of valvular heart disease. Eur Heart J. 2021;42(5):419–500. DOI: 10.1093/eurheartj/ehaa100
[2] Otto CM, Nishimura RA, Bonow RO, Carabello BA, Erwin JP, Gentile F, et al. 2020 ACC/AHA guideline for the management of patients with valvular heart disease. Circulation. 2021;143(5):72–227. DOI: 10.1161/CIR.0000000000000923
[3] Heidenreich PA, Bozkurt B, Aguilar D, Allen LA, Byun JJ, Colvin MM, et al. 2022 AHA/ACC/HFSA Guideline for the management of heart failure. J Am Coll Cardiol. 2022;79(17):263–421. DOI: 10.1016/j.jacc.2021.12.012
[4] Lancellotti P, Pibarot P, Chambers J, La Canna G, Pepi M, Dulgheru R, et al. Multi-modality imaging assessment of native valvular regurgitation: An EACVI and ESC council of valvular heart disease position paper. Eur Heart J Cardiovasc Imaging. 2022;23(5):171–232. DOI: 10.1093/ehjci/jeab253
[5] Coats AJS, Anker SD, Baumbach A, Alfieri O, von Bardeleben RS, Bauersachs J, et al. The management of secondary mitral regurgitation in patients with heart failure: A joint position statement from the HFA, EACVI, EHRA, and EAPCI of the ESC. Eur Heart J. 2021;42(13):1254–69. DOI: 10.1093/eurheartj/ehab086
[6] Witkowski TG, Thomas JD, Delgado V, van Rijnsoever E, Ng AC, Hoke U, et al. Changes in left ventricular function after mitral valve repair for severe organic mitral regurgitation. Ann Thorac Surg. 2012;93(3):754–60. DOI: 10.1016/j.athoracsur.2011.11.034
[7] Benfari G, Antoine C, Essayagh B, Batista R, Maalouf J, Rossi A, et al. Functional mitral regurgitation outcome and grading in heart failure with reduced ejection fraction. JACC Cardiovasc Imaging. 2021;14(12):2303–15. DOI: 10.1016/j.jcmg.2021.05.017
[8] Joung KW, Kim S, Nam JS, Choi YS, Shim JK, Lee S, et al. Changes in left ventricular ejection fraction after mitral valve repair for primary mitral regurgitation. J Clin Med. 2021;10(13):2830. DOI: 10.3390/jcm10132830
[9] Iung B, Messika-Zeitoun D, Boutitie F, Trochu JN, Armoiry X, Maucort-Boulch D, et al. Characteristics and outcome of patients eligible for the COAPT trial in the MITRA-FR trial. Circulation. 2020;142(25):2482–4. DOI: 10.1161/CIRCULATIONAHA.120.049743
[10] Messika-Zeitoun D, Iung B, Armoiry X, Trochu JN, Donal E, Habib G, et al. Impact of mitral regurgitation severity and left ventricular remodeling on outcome after MitraClip implantation: Results from the MITRA-FR trial. JACC Cardiovasc Imaging. 2021;14(4):742–52. DOI: 10.1016/j.jcmg.2020.07.021
[11] Suri RM, Schaff HV, Dearani JA, Sundt TM, Daly RC, Mullany CJ, et al. Recovery of left ventricular function after surgical correction of mitral regurgitation caused by leaflet prolapse. J Thorac Cardiovasc Surg. 2009;137(5):1071–6. DOI: 10.1016/j.jtcvs.2008.10.026
[12] Mack MJ, Lindenfeld J, Abraham WT, Kar S, Lim DS, Mishell JM, et al. 3-year outcomes of transcatheter mitral valve repair in patients with heart failure. J Am Coll Cardiol. 2021;77(8):1029–40. DOI: 10.1016/j.jacc.2020.12.047
[13] Stone GW, Abraham WT, Lindenfeld J, Kar S, Grayburn PA, Lim S, et al. Five-year outcomes of transcatheter mitral valve repair in patients with heart failure. N Engl J Med. 2024;390(15):1395–404. DOI: 10.1056/NEJMoa2300213
[14] Quintana E, Suri RM, Thalji NM, Daly RC, Dearani JA, Burkhart HM, et al. Left ventricular dysfunction after mitral valve repair – the fallacy of "normal" preoperative myocardial function. J Thorac Cardiovasc Surg. 2014;148(6):2752–62. DOI: 10.1016/j.jtcvs.2014.07.029
[15] Tomšič A, de Weger A, van der Stoel M, Klautz RJM, Palmen M. Nationwide study: Mitral valve repair and replacement for active endocarditis. Ann Thorac Surg. 2024;117(1):120–6. DOI: 10.1016/j.athoracsur.2023.08.032
[16] Salsano A, Nenna A, Molinari N, Singh SSA, Spadaccio C, Santini F, et al. Impact of mitral regurgitation recurrence on mitral valve repair for secondary ischemic mitral regurgitation. J Cardiovasc Dev Dis. 2023;10(3):124. DOI: 10.3390/jcdd10030124
[17] Sudo M, Vij V, Wilde N, Tanaka T, Vogelhuber J, Silaschi M, et al. Contemporary treatment and outcomes of high surgical risk mitral regurgitation. J Clin Med. 2023;12(8):2978. DOI: 10.3390/jcm12082978
[18] Eapen SR, Zaky MH, Kostibas MP, Robich MP. Secondary mitral regurgitation surgical management: A narrative review. Cardiovasc Diagn Ther. 2024;14(5):958–73. DOI: 10.21037/cdt-24-6
[19] Declaration of Helsinki [Internet]. [cited 2025 December 21]. Available from: https://www.wma.net
[20] Dolgin E, editor. Nomenclature and criteria for diagnosis of diseases of the heart and great vessels. 9th ed. Boston: Little, Brown; 1994. 334 P.
[21] Lang RM, Badano LP, Mor-Avi V, Afilalo J, Armstrong A, Ernande L, et al. Recommendations for cardiac chamber quantification by echocardiography in adults: An update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. J Am Soc Echocardiogr. 2015;28(1):1–39. DOI: 10.1016/j.echo.2014.10.003

[22] Osaulenko VV, Hubka VO, Chmul KO, Nakonechnyi SY, Budahov RI. Clinical outcomes of valve-sparing reconstructive surgery for ischemic mitral regurgitation: A 5-year single-center report and review of current global trends. Zaporizhzhia Med J. 2025;27(4):273–80. DOI: 10.14739/2310-1210.2025.4.331047

Динаміка змін фракції викиду лівого шлуночка після хірургічної корекції мітральної недостатності

Святослав Костів
Доктор медичних наук, професор
Тернопільський національний медичний університет ім. І.Я. Горбачевського
46001, майдан Волі, 1, м. Тернопіль, Україна
https://orcid.org/0000-0002-7963-5425

Дмитро Коваль
Аспірант
Тернопільський національний медичний університет ім. І.Я. Горбачевського
46001, майдан Волі, 1, м. Тернопіль, Україна
https://orcid.org/0009-0001-4077-0670

Станіслав Ліщенко
Лікар-кардіохірург
Львівський національний медичний університет ім. Данила Галицького
79010, вул. Чернігівська, 7, м. Львів, Україна
https://orcid.org/0009-0008-1902-3831

Ігор Процик
Лікар-кардіохірург
Львівський національний медичний університет ім. Данила Галицького
79010, вул. Чернігівська, 7, м. Львів, Україна
https://orcid.org/0009-0007-4426-5130

Віталій Степанюк
Лікар-кардіохірург
Львівський національний медичний університет ім. Данила Галицького
79010, вул. Чернігівська, 7, м. Львів, Україна
https://orcid.org/0009-0004-5156-5631

Анотація. Мітральна недостатність є однією із найпоширеніших уражень клапанного апарату серця та призводить до хронічного перевантаження об'ємом, дилатації та ремоделювання лівого шлуночка. Попри ефективність сучасних хірургічних методик корекції мітральної регургітації, питання раннього відновлення систолічної функції та темпів зворотного ремоделювання залишаються клінічно значущими. Метою цього дослідження було оцінити ранні післяопераційні зміни систолічної функції лівого шлуночка та проаналізувати динаміку фракції викиду як маркера ефективності хірургічної корекції мітральної регургітації. У дослідженні взяли участь 40 пацієнтів із мітральною недостатністю III-IV ступеня, яким було виконано пластичну реконструкцію мітрального клапана (45 %) або протезування (55 %). Ехокардіографію проводили тричі – до операції, через 1 місяць та через 3 місяці після хірургічного втручання. Фракцію викиду визначали методом двоплощинного Сімпсона відповідно до рекомендацій ASE/EACVI. Статистичну обробку було виконано із використанням вбудованих інструментів Microsoft Excel із розрахунком середніх значень, стандартного відхилення та відсоткової зміни показників. До операції середня фракція викиду становила 48,2 %. Через 1 місяць вона зросла до 51,7 %, а через 3 місяці – до 54,9 %, що свідчило про ранні процеси зворотного ремоделювання. Найбільш виражене покращення відзначено у пацієнтів із вихідною фракцією викиду менше 50 % (приріст 8-10 %). Після пластики мітрального клапана динаміка була кращою порівняно з протезуванням (7-9 % проти 5-6 %). 75 % пацієнтів продемонстрували позитивну динаміку вже через місяць після операції. Хірургічна корекція мітральної недостатності забезпечує суттєве раннє покращення систолічної функції лівого шлуночка. Динаміка фракції викиду у перші 1-3 місяці є важливим прогностичним інструментом, що дозволяє оцінити ефективність втручання, темпи зворотного ремоделювання та оптимізувати подальше лікування пацієнтів

Ключові слова: зворотне ремоделювання; ехокардіографія; систолічна функція; анулопластика; протезування клапанів; післяопераційне відновлення; скоротливість міокарда