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Preoperative Pulmonary Artery Systolic Pressure and Survival in Patients Undergoing Valve Replacement for Mitral Stenosis

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ABSTRACT

Introduction: High pulmonary artery pressure (PAP) is a critical survival parameter in patients with severe mitral stenosis. We investigated changes in PAP and their impact on survival in patients undergoing mitral valve replacement for severe mitral stenosis.

Methods: We retrospectively analyzed 42 patients who underwent mitral valve replacement for severe mitral stenosis between January 2020 and January 2022. Changes in systolic pulmonary artery pressure (sPAP) assessed by echocardiography and survival outcomes were analyzed.

Results: The mean age of the patients was 56.05±14.21 years. Among the patients, 71.4% were female and 28.6% were male. The median postoperative sPAP was 29 mmHg, which was significantly lower than the preoperative value ($p<0.001$). In the subgroup analysis according to preoperative sPAP value, the postoperative sPAP change was 17.87% in <50 mmHg group and 41.61% in ≥50 mmHg group, which indicated a statistically significant difference ($p=0.003$). In the patient group with preoperative sPAP <50 mmHg, the expected 3-year survival rate was 85.2% compared with 75.8% in the patient group with sPAP ≥50 mmHg, and the differences were insignificant ($p=0.510$).

Conclusion: Patients with severe mitral stenosis and high sPAP can undergo surgery with acceptable survival expectancy. However, the decrease in pulmonary pressure in the early postoperative period alone cannot adequately predict survival.

Keywords: Mitral stenosis, mitral valve, pulmonary artery, survival rate

Introduction

Mitral stenosis is a heart valve disease that develops on a rheumatic or degenerative basis, is associated with high mortality rates when left untreated, and remains a significant problem in developing countries (1). When the stenosis in the mitral valve orifice drops below 1.5 cm^2, the passage of blood from the left atrium to the left ventricle becomes difficult during diastole, leading to an increase in the transmitral pressure gradient (2). Because of increased pressure in the left atrium and pulmonary circulation, permanent or reversible changes may occur in the pulmonary vascular bed. When the disease is left untreated, symptoms such as palpitations, shortness of breath, weakness, and peripheral edema may emerge because of increased pulmonary pressure.

Medical treatment alone is insufficient for mitral stenosis, which is a mechanical problem. Percutaneous mitral commissurotomy (PMC) and mitral valve replacement are treatment strategies aimed at increasing the valve area. PMC is a less invasive method; however, because of limitations in its applicability, mitral valve replacement remains the primary treatment option for severe mitral stenosis (3).

In patients with mitral stenosis, left ventricular function is usually preserved, whereas systolic pulmonary artery pressures (sPAP) are generally high. An sPAP >50 mmHg is considered a heightened risk of increased hemodynamic decompensation (4). Surgery is particularly indicated for patients at high risk of hemodynamic decompensation (3). However, this situation raises concerns among surgeons because of the decrease in survival expectancy (5). Despite these concerns, there is limited evidence regarding the impact of preoperative elevation in sPAP on survival.

The aim of this study was to investigate the effect of preoperative elevation of sPAP on survival in patients undergoing mitral valve replacement due to severe mitral stenosis.

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Methods

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board for Non-Interventional Clinical Research of Aydın Adnan Menderes University Faculty of Medicine (approval number: 2022/126, date: 04.08.2022). Digital and manual patient records were retrospectively reviewed at the Department of Cardiovascular Surgery, Aydın Adnan Menderes University Faculty of Medicine.

The study included all patients who underwent surgery between January 2020 and January 2022, with the primary indication being severe mitral stenosis. Emergency surgeries, redo surgeries, patients who underwent surgery because of infective endocarditis, and patients who underwent concomitant aortic valve surgery were excluded from the study. The surgical decision was made by the university's cardiac specialists, considering the current guidelines.

The echocardiographic parameters of the patients were measured preoperatively and after 3 months postoperatively, and the changes between the two groups were analyzed. The echocardiographic parameters analyzed were sPAP, mean mitral valve gradient, mitral valve area, and left ventricular ejection fraction.

Tricuspid regurgitation was localized using Doppler color flow imaging. The peak flow velocity of the transtricuspid jet was measured using continuous-wave Doppler spectroscopy, and the pressure gradient between the right ventricle and right atrium was calculated using the modified Bernoulli equation. sPAP was estimated by adding the clinically determined mean jugular venous pressure.

The demographic and preoperative data of the patients included age, sex, hypertension, diabetes mellitus, hyperlipidemia, coronary artery disease, end-stage renal failure, and atrial fibrillation. Information on length of hospital stay, time of discharge, a type of valve used, and mortality was obtained from the university's digital record system.

The surgeries were performed under general anesthesia via a median sternotomy incision using classic cardiopulmonary bypass techniques and antegrade cold-blood cardioplegia. The aortic cross-clamping and cardiopulmonary bypass durations were recorded. All surgeries included mitral valve replacement, with additional procedures including coronary artery bypass graft and tricuspid valve surgery. Operations are conducted by different teams; standard and similar protocols are applied in terms of technique and strategy.

Statistical Analysis

Statistical analysis was performed using SPSS 26.0 software (SPSS Inc., Chicago, IL). The Kolmogorov-Smirnov test was used to evaluate the conformity of the data to the normal distribution. Normally distributed data were expressed as mean and standard deviation, whereas non-normally distributed data were expressed as median and quartiles. Frequency and percentage were used to present categorical data. In the comparison of preoperative and postoperative continuous variables, the paired samples t-test was used for normally distributed data, and the Wilcoxon signed-rank test was used for non-normally distributed data. The Kaplan-Meier method was used for survival analysis. A $p<0.05$ was set as statistically significant in all analyses.

Results

The mean age of the 42 patients evaluated in the study was 56.05±14.21 years. Of the patients, 30 (71.4%) were female and 12 (28.6%) were male. The demographic characteristics and comorbidities of the patients are presented in Table 1. There were no significant differences in comorbidities between the groups of patients who died and those who did not. The median preoperative sPAP was 44 mmHg, and 14 (33.3%) patients had sPAP values ≥50 mmHg. The median left ventricular ejection fraction was 60.29. The mean gradient detected by echocardiography for the mitral valve was 9 mmHg, and the mean valve area was 1.39±0.38 cm^2.

Isolated mitral valve replacement was performed in 25 patients (59.52%). Two patients underwent coronary artery bypass grafting during the same session because of concomitant coronary artery disease. Fifteen patients underwent concomitant surgical treatment due to tricuspid regurgitation (Table 2). For mitral valve replacement, mechanical valves were preferred in 32 patients (76.2%), whereas bioprosthetic valves were

Table 1. Patient characteristics and comorbidities

	Total (n=42)	Survivor (n=34)	Non-survivor (n=8)	p-value
Age (mean ± SD)	56.05±14.21	53.71±13.85	67±11.73	0.027*
Sex, n (%)				0.589 (+)
Male	12 (28.6)	10 (39.4)	2 (25)	
Female	30 (71.4)	24 (70.6)	6 (75)	
Atrial fibrillation, n (%)	29 (69)	22 (64.7)	7 (87.5)	0.398 (+)
Diabetes mellitus, n (%)	8 (19)	6 (17.6)	2 (25)	0.482 (+)
Hyperlipidemia, n (%)	11 (26.2)	10 (29.4)	1 (12.5)	0.312 (+)
Hypertension, n (%)	19 (45.2)	14 (41.2)	5 (62.5)	0.243 (+)
Coronary artery disease, n (%)	7 (16.7)	4 (11.8)	3 (37.5)	0.113 (+)
Chronic renal failure, n (%)	4 (9.5)	2 (5.9)	2 (25)	0.158 (+)
Smoking frequency, n (%)	8 (19)	7 (20.6)	1 (12.5)	0.518 (+)

SD: Standard deviation, *: Mann-Whitney U test, (+): Chi-squared test.

preferred in 10 patients (23.8%). The median cardiopulmonary bypass duration was 152.5 min, whereas the median cross-clamp duration was 100.5 min. The median length of hospital stay in the intensive care unit was 4 days, whereas the median length of hospital stay until discharge was 7 days.

The median postoperative sPAP was 29 mmHg, which was significantly lower than the preoperative sPAP (p<0.001). Other echocardiographic parameters and their comparisons with the preoperative period are presented in Table 3.

In the subgroup analysis based on preoperative sPAP values, the postoperative change in sPAP was 17.87% in patients with sPAP <50 mmHg and 41.61% in those with sPAP ≥50 mmHg. A significant difference was observed between the two groups in terms of postoperative sPAP change (p=0.003) (Figure 1).

The median follow-up period was 35.6 months, and mortality was observed in 8 (19%) patients. The expected 1-year and 3-year survival rates were 88.1% and 81.6%, respectively. In the patient group with preoperative sPAP <50 mmHg, the expected 1-year and 3-year survival rates were 88.9% and 85.2%, respectively. In the patient group with preoperative sPAP value ≥50 mmHg, the expected 1-year and 3-year survival rates were 86.7% and 75.8%, respectively. There was no statistically significant difference between the two groups in terms of survival expectancy (p=0.510) (Figure 2).

Discussion

In this study involving patients who underwent mitral valve replacement due to severe mitral stenosis, two important findings were noted regarding the change in sPAP. First, a significant decrease in sPAP was observed in the early period. The pressure decrease was more pronounced in patients with preoperative sPAP values above the haemodynamic decompensation threshold of 50 mmHg compared with the group with values <50 mmHg. Second, no significant difference in midterm survival outcomes was observed between the two patient groups.

Table 2. Surgical treatments performed

	(n=42)
	n (%)
Isolated mitral valve replacement	25 (59.52)
Mitral valve replacement + Coronary artery bypass grafting	2 (4.76)
Mitral valve replacement + De Vega annuloplasty	8 (19.05)
Mitral valve replacement + Tricuspid ring annuloplasty	4 (9.52)
Mitral valve replacement + Tricuspid valve replacement	3 (7.14)

The incidence of rheumatic heart disease is gradually decreasing with the widespread adoption of treatment for acute rheumatic fever. However, mitral stenosis and its related complications remain significant health concerns, particularly in developing countries. Every year, approximately

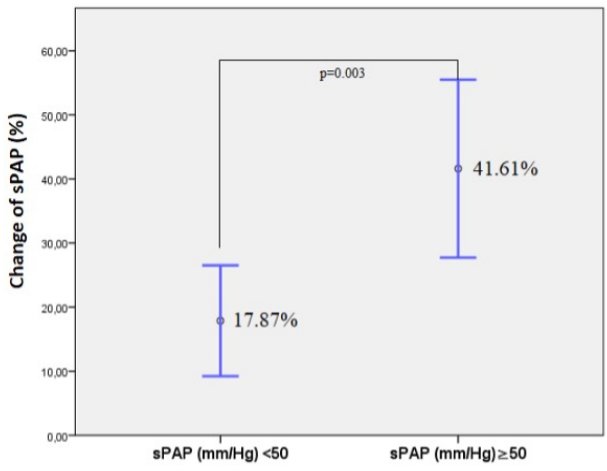

Figure 1. Comparison of postoperative sPAP changes between sPAP <50 and ≥50 mmHg groups
sPAP: Systolic pulmonary artery pressure

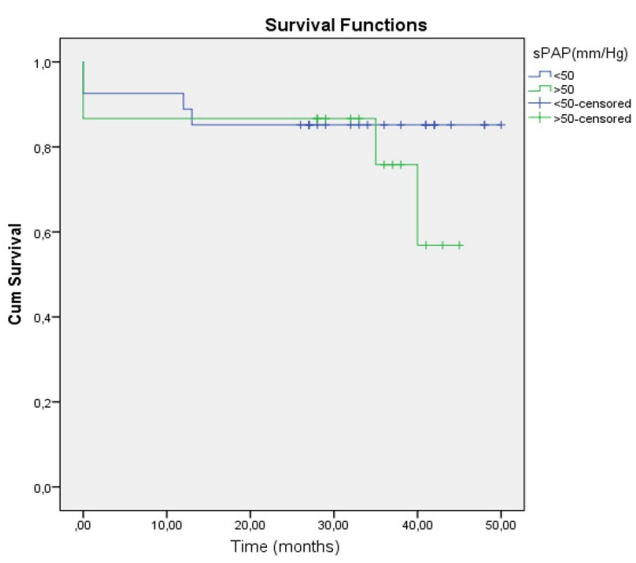

Figure 2. Kaplan-Meier method showing the survival expectancy of sPAP <50 and ≥50 mmHg groups
sPAP: Systolic pulmonary artery pressure

Table 3. Comparison of preoperative and postoperative echocardiographic variables

	(n=42)		
	Preoperative value	Postoperative value	p-value
sPAP (mmHg), median (IQR)	44 (23)	29 (15)	<0.001*
Left ventricular ejection fraction (%), median (IQR)	65 (5)	60 (5)	0.006*
Mean gradient (mmHg) and median (IQR)	9 (5)	4 (2)	<0.001*
Valve area (cm^2), mean ± SD	1.39±0.38	2.74±0.45	<0.001 (+)

IQR: Interquartile range, sPAP: Systolic pulmonary arterial pressure, SD: Standard deviation, *: Wilcoxon signed-rank test, (+): Paired samples t-test

4.8 out of 100,000 individuals die because of these diseases (6). Mitral valve replacement, one of the most effective treatment methods for preventing complications and mortality, aims to reduce the valve gradient to prevent congestion in the pulmonary circulation and periphery. When exposed to high pressures for prolonged periods, pulmonary vascular bed hypertrophy and vasoconstriction can develop, leading to persistent pulmonary hypertension that may not adequately respond to surgical treatment (7). The elevation of sPAP because of mitral stenosis can be concerning for cardiac surgeons during decision-making for surgery, as it may negatively impact both short-term and long-term survival (5). This concern arises from the possible lack of sufficient improvement in sPAP values despite normalization of postoperative left atrial pressures in patients with mitral stenosis, which could decrease survival expectations. The calculation of sPAP using noninvasive echocardiography and its insufficiency on it's own in evaluating the pulmonary vascular bed further exacerbate this concern (8).

In a retrospective descriptive study by Briongos Figuero et al. (7) involving 111 patients, preoperative high sPAP could persist after mitral valve replacement. In another study conducted by Walls et al. (9), pulmonary pressures decreased after mitral valve replacement and physiological repair, regardless of the surgical type. Consistent with these reports, sPAP values decreased significantly in the early postoperative period compared with preoperative values in the present study. The primary reason for the decrease in sPAP in the early postoperative period is the reduction in left atrial pressure because of the resolution of the mechanical problem. In the present study, although the percentage decrease in postoperative sPAP values was higher among patients with preoperative sPAP values >50 mmHg, this result did not significantly impact survival. This indicates that sPAP values alone are not sufficient to evaluate the pulmonary vascular bed and that postoperative decreases in sPAP are not sufficient to predict survival.

The risks associated with high pulmonary pressure in patients undergoing mitral valve replacement are unclear. In the study conducted by Cámara et al. (10) with 88 patients and an average follow-up duration of 44 months, the 5-year expected survival rate was 86%. In this study, survival analysis was conducted without classifying the PAP values. In a retrospective study conducted by Vincens et al. (11) involving 43 patients, the 5-year expected survival rate was 80%. In this study, all patients had sPAP values >60 mmHg, and survival analysis was performed by grouping patients according to their ages. In a retrospective study conducted by Yang et al. (5) involving 317 patients, postoperative long-term survival was significantly reduced in patients with mitral stenosis and higher pulmonary pressures compared with those with lower pressures. In the present study, the 3-year expected survival rate was 81.6%, and a lower survival rate was observed in the group with sPAP values >50 mmHg. Consistent with the study of Yang et al. (5), midterm follow-up revealed that survival rates were lower in patients with high pulmonary pressure. However, no significant difference was observed.

Study Limitations

There are certain limitations to this study. The study was conducted at a single center, and the sample size was relatively small. Symptomatic evaluation could not be performed in the two groups due to insufficient data on the change in functional capacity of the patients. The necessary data to calculate preoperative surgical risk scores were not obtained. The use of different valve brands was considered a limitation of the study. Echocardiographic assessment of pulmonary pressure and lack of invasive confirmation is another limitation of the study.

Conclusion

In severe mitral stenosis, preoperative high sPAP values can be reduced by achieving an appropriate valve area through valve replacement, and acceptable survival rates can be achieved. However, a decrease in sPAP alone in the early period is not sufficient to evaluate midterm survival.

Ethics Committee Approval: This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board for Non-Interventional Clinical Research of Aydın Adnan Menderes University Faculty of Medicine (approval number: 2022/126, date: 04.08.2022).

Informed Consent: Retrospective study.

Authorship Contributions: Surgical and Medical Practices - S.D.; Concept - Ö.F.R.; Design - Ö.F.R.; Data Collection or Processing - F.A.; Analysis or Interpretation - Ö.F.R.; Literature Search - F.A.; Writing - F.A.

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References

1. Harb SC, Griffin BP. Mitral valve disease: a comprehensive review. Curr Cardiol Rep. 2017; 19: 73.
2. Kato N, Padang R, Scott CG, Guerrero M, Pislaru SV, Pellikka PA. The natural history of severe calcific mitral stenosis. J Am Coll Cardiol. 2020; 75: 3048-57.
3. 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. 2022; 43: 561-632.
4. Galusko V, Ionescu A, Edwards A, Sekar B, Wong K, Patel K, Lloyd G, Ricci F, Khanji MY. Management of mitral stenosis: a systematic review of clinical practice guidelines and recommendations. Eur Heart J Qual Care Clin Outcomes. 2022; 8: 602-18.
5. Yang B, DeBenedictus C, Watt T, Farley S, Salita A, Hornsby W, et al. The impact of concomitant pulmonary hypertension on early and late outcomes following surgery for mitral stenosis. J Thorac Cardiovasc Surg. 2016; 152: 394-400.
6. Watkins DA, Johnson CO, Colquhoun SM, Karthikeyan G, Beaton A, Bukhman G, et al. Global, regional, and national burden of rheumatic heart disease, 1990-2015. N Engl J Med. 2017; 377: 713-22.
7. Briongos Figuero S, Moya Mur JL, García-Lledó A, Centella T, Salido L, Aceña Navarro Á, et al. Predictors of persistent pulmonary hypertension after mitral valve replacement. Heart Vessels. 2016; 31: 1091-9.
8. Huston JH, Shah SJ. Understanding the pathobiology of pulmonary hypertension due to left heart disease. Circ Res. 2022; 130: 1382-403.
9. Walls MC, Cimino N, Bolling SF, Bach DS. Persistent pulmonary hypertension after mitral valve surgery: does surgical procedure affect outcome? J Heart Valve Dis. 2008; 17: 1-9.
10. Cámara ML, Aris A, Padró JM, Caralps JM. Long-term results of mitral valve surgery in patients with severe pulmonary hypertension. Ann Thorac Surg. 1988; 45: 133-6.
11. Vincens JJ, Temizer D, Post JR, Edmunds LH Jr, Herrmann HC. Long-term outcome of cardiac surgery in patients with mitral stenosis and severe pulmonary hypertension. Circulation. 1995; 92: II137-42.