Open access Original article

Doppler Echocardiographic Hemodynamic Changes Following Percutaneous Balloon Mitral Valvotomy

Mohammad Abdul Gaffar,[1] Jannatul Ferdous,[2] Sharmin Shahnaz Suchi[3]

1. Assistant Professor
   Department of Cardiology
   National Institute of Cardiovascular Diseases & Hospital
   Dhaka, Bangladesh
2. Assistant Professor
   Department of Cardiology
   National Institute of Cardiovascular Diseases & Hospital
   Dhaka, Bangladesh
3. Medicine Specialist
   Dhaka Medical College & Hospital
   Dhaka, Bangladesh

Correspondence to:
Mohammad Abdul Gaffar
Assistant Professor
Department of Cardiology
National Institute of Cardiovascular Diseases & Hospital
Dhaka, Bangladesh
Email: robelcmc@gmail.com

Submission Date : 07 Jan 2026
Accepted Date : 19 Feb 2026
Published Date : 30 March 2026
DOI: https://doi.org/10.3329/jrpmc.v11i1.89956

Abstract

Background:
Rheumatic mitral stenosis is a major cardiovascular burden in poorer nations, causing increasing hemodynamic compromise. Percutaneous balloon mitral valvotomy (PBMV) has emerged as the preferred treatment for symptomatic mitral stenosis with a healthy valve shape.

Objective:
This study aimed to assess the doppler echocardiographic hemodynamic changes following PBMV in individuals with rheumatic mitral stenosis.

Methods:
This prospective observational analysis comprised 24 patients with severe rheumatic mitral stenosis who received PBMV between January and July 2021 at the National Institute of Cardiovascular Diseases in Dhaka, Bangladesh. Patients aged 21-50 years with a Wilkins score ≤10 were enrolled. Transthoracic doppler echocardiography was performed 24 hours before and 24-48 hours after PBMV to measure peak transmitral pressure gradient, mean transmitral pressure gradient, and pulmonary artery systolic pressure. A paired Student's t-test was used for statistical analysis, with a significance level of p≤0.05.

Results:
The study cohort was largely female (70.8%), with a mean age range of 21-50 years. All patients complained of shortness of breath, and additional prevalent symptoms included palpitation (87.5%) and paroxysmal nocturnal dyspnea (83.33%). After PBMV, peak transmitral pressure gradient decreased from 18.04±5.23 mmHg to 12.42±5.87 mmHg (31.2% reduction, p=0.0001), mean transmitral pressure gradient decreased from 10.75±3.15 mmHg to 7.04±4.53 mmHg (34.5% reduction, p=0.0001), and pulmonary artery systolic pressure decreased from 33.50±17.41 mmHg to 25.63±13.83 mmHg (23.5% reduction, p=0.003).

Conclusion:
In individuals with rheumatic mitral stenosis, PBMV immediately improves doppler hemodynamic parameters such as transmitral pressure gradients and pulmonary artery pressure. These data show PBMV's efficacy in improving hemodynamic outcomes and support its use as the recommended strategy for appropriate patients with mitral stenosis.

Keywords: Percutaneous balloon mitral valvotomy, Doppler echocardiography, Mitral stenosis, Hemodynamic changes

Citation: Gaffar MA,Ferdous J,Suchi SS.Doppler Echocardiographic Hemodynamic Changes Following Percutaneous Balloon Mitral Valvotomy.J Rang Med Col.2026 Mar;11(1):63-68.doi: https://doi.org/10.3329/jrpmc.v11i1.89956

Introduction:

Rheumatic heart disease is a significant cause of cardiovascular morbidity and mortality in developing countries, and the most common valve affected is the mitral valve.[1] The burden of rheumatic heart disease worldwide is approximately 33 million people, and the prevalence is highest in South Asia, Africa, and the Middle East.[2] As the severity of the mitral stenosis progresses, left atrial pressure increases, which

leads to pulmonary hypertension and ultimately compromises the right ventricle, thereby affecting the quality of life and survival.[3] The treatment of rheumatic mitral stenosis has been revolutionised by the introduction of percutaneous balloon mitral valvotomy (PBMV), which was first described by Inoue in the 1980s.[4] PBMV splits the fused commissures mechanically, thereby increasing the valve area immediately and reducing the gradient across the valve.[5] Several randomised trials have proven that the results obtained by PBMV are comparable to those obtained by surgical commissurotomy, but the morbidity, hospital stay, and cost are less in PBMV, making it the treatment of choice for symptomatic patients with favourable valve morphology.[6] Doppler echocardiography is of critical importance in the comprehensive evaluation of the severity and hemodynamic consequences of mitral stenosis.[7] It is a useful tool in measuring transmitral pressure gradients, pulmonary artery pressure, and cardiac chamber sizes, which are essential in planning and evaluation of the procedure and its outcomes.[8] The immediate hemodynamic effects of PBMV can be quantitatively assessed by Doppler echocardiography, which is an important predictor of successful outcomes.[9] The pathophysiology of mitral stenosis is associated with a gradually narrowing mitral valve area, usually due to rheumatic inflammation of the valve, which causes thickening of the valve leaflets and fusion of the commissures, along with involvement of the subvalvular apparatus.[10] As the valve area is reduced to less than 1.5cm, a significant interatrial pressure gradient is created, causing an increase in left atrial size and pulmonary venous pressure. Prolonged pulmonary venous hypertension causes a reactive vasoconstriction of the pulmonary arteries, leading to pulmonary hypertension, which is irreversible if untreated.[11] Although many studies have demonstrated the long-term clinical efficacy of PBMV, there is still interest in understanding the immediate hemodynamic effects that occur post-procedure. Analysis of these early effects can provide information on the mechanism of efficacy, assist in the identification of patients at risk for poor outcomes, and inform post-procedure management strategies. The degree of reduction in transmitral gradients and pulmonary artery pressure post-PBMV has been demonstrated to correlate with symptomatic improvement and event-free survival in follow-up analysis. Thus, the assessment of Doppler hemodynamic parameters in the early post-procedure period continues to be an important aspect of patient management and further supports the efficacy of PBMV as a therapeutic modality for patients with mitral stenosis.

Methods:

This prospective observational study was carried out at the Department of Cardiology, National Institute of Cardiovascular Diseases, Dhaka, Bangladesh, from January to July 2021. Ethical permission for conducting this study was obtained from the Institutional Ethical Review Committee, and consent was obtained from all the participants before the study. Patients with chronic rheumatic heart disease with severe mitral stenosis undergoing PBMV during the index hospitalisation were included in the study. The inclusion criteria for the patients were an age group between 15 and 45 years, a suitable valve for PBMV, and chronic rheumatic heart disease with severe mitral stenosis. The exclusion criteria for the patients included mild mitral stenosis, unfavorable valve for PBMV, coronary artery disease, left ventricular ejection fraction less than 50 percent, moderate to severe associated valvular disease, left ventricular ejection fraction less than 50 percent, right heart failure, and atrioventricular conduction abnormality. Baseline evaluation consisted of a detailed clinical history and examination, and the collection of demographic data using a case record form. All patients underwent a comprehensive evaluation, including routine laboratory investigations, a 12-lead electrocardiogram, and a chest X-ray. Transthoracic echocardiography using standard protocols assessed mitral valve anatomy, dimensions, and function. Mitral valve area measurement using planimetry in the parasternal short-axis view and mitral valve scoring using the Wilkins scoring system were performed. Doppler echocardiography measured peak and mean transmitral gradients and pulmonary artery systolic pressure from tricuspid regurgitant velocity. Echocardiographic evaluation was performed one day before PBMV and after 24 to 48 hours using the same technique and the same experienced operator, unaware of the clinical outcomes. Data analysis was performed using SPSS software version 26.0. Data were expressed as mean and

standard deviation, and categorical data were expressed in terms of numbers and percentages. Paired student 't' test was applied to compare pre and post-procedure data. $p<0.05$ was considered statistically significant.

Results:

The cohort included 24 patients, with the 31-40 years age group accounting for 45.8%, followed by 41-50 years (29.2%) and 21-30 years (25.0%). Female patients made up the majority (70.8%) which is consistent with the known gender distribution of rheumatic mitral stenosis in endemic areas (Table-I).

All patients had dyspnea (100%), showing severe mitral stenosis. Common symptoms included palpitations (87.5%) and paroxysmal nocturnal dyspnea (83.33%). Most had rheumatic fever (87.5%), but only one-third received preventive antibiotics (Table-II).

The average pulse rate was 80.46±9.08 bpm, while blood pressure averaged 127.14±15.75/80.70±9.16 mmHg. Despite significant valve stenosis, the jugular venous pressure of 8.94±0.296 cm was normal, indicating compensatory hemodynamics (Table-III).

Table-I: Distribution of studied samples by demographic profiles (N=24)

Demographics	no.(%)
Age (years)	
21-30	6(25.0)
31-40	11(45.8)
41-50	7(29.2)
Gender	
Female	17(70.8)
Male	7(29.2)

Table-II: Clinical features of the respondents (N=24)

Symptoms	no.(%)
Breathlessness	24(100)
Palpitation	21(87.5)
Chest pain	9(37.5)
Cough	9(37.5)
Paroxysmal nocturnal dyspnea	20(83.33)
Orthopnea	6(25)
History of rheumatic fever	21(87.5)
History of rheumatic fever prophylaxis	8(33.33)

Table-III: General examination findings of the respondents (N=24)

Variables	Mean±SD
Pulse (bpm)	80.46±9.08
Systolic blood pressure (mmHg)	127.14±15.75
Diastolic blood pressure (mmHg)	80.70±9.16
Jugular venous pressure (cm)	8.94±0.296

Statistically substantial improvements were found across all the parameters assessed. The treatment effectively relieved mitral stenosis and improved hemodynamics. Peak transmitral gradient dropped by 31.2%, mean gradient by 34.5%, and pulmonary artery pressure by 23.5%, all with extremely significant p-values ($p\leq0.003$) (Table-IV).

Table-IV: Comparison of doppler echocardiographic findings before and after PBMV (N=24)

Doppler parameter	Pre-PBMV mean±SD	Post-PBMV mean±SD	Absolute change	Percentage change	p-value
Peak transmitral pressure gradient (mmHg)	18.04±5.23	12.42±5.87	-5.62	-31.2%	0.0001
Mean transmitral pressure gradient (mmHg)	10.75±3.15	7.04±4.53	-3.71	-34.5%	0.0001
Pulmonary artery pressure (mmHg)	33.50±17.41	25.63±13.83	-7.87	-23.5%	0.003

Discussion:

This study showed the immediate hemodynamic benefit of PBMV in patients with rheumatic mitral stenosis, as reflected by the marked reduction in transmitral pressure gradients and pulmonary artery systolic pressures. These results are in keeping with those of Fawzy et al, who support PBMV as an effective percutaneous procedure for patients with symptomatic mitral stenosis.[12] The 31.2% reduction in peak transmitral gradient and 34.5% reduction in mean gradient noted in our study are in keeping with Silva et al, who documented similar degrees of hemodynamic benefit following successful balloon valvotomy.[13] The demographic distribution of our population, which predominantly consists of young females, is in keeping with the usual distribution of rheumatic mitral stenosis. Sharma et al found a similar gender ratio, with females contributing 60-75% of the population undergoing PBMV.[14] The age distribution of our patients in the third and fourth decades of life is in keeping with the study by Sampath et al, who showed that the natural history of rheumatic valve disease, where severe stenosis occurs 15-20 years after the acute episode of rheumatic fever.[15] The presence of breathlessness and paroxysmal nocturnal dyspnea in all our patients emphasises the advanced stage of symptoms, which requires strategies for earlier detection and intervention. The reduction in pulmonary artery pressures, as demonstrated by our results, to the extent of 23.5%, assumes special significance when viewed from a prognostic perspective. Pulmonary artery pressures are well recognised as an independent predictor of poor outcome in patients with mitral stenosis, and their reduction following PBMV has been correlated with improved survival and functional status of the patients.[15] Several factors are thought to contribute to the reduction of pulmonary artery pressures following successful valvotomy, including the immediate reduction of the increased pulmonary venous pressures, reflected as increased left atrial pressures, and the delayed reduction of reactive pulmonary vascular resistance, leading to pulmonary vasoconstriction, over a period of time following successful valvotomy.[16] This reduction of pulmonary artery pressures, compared to the reduction of the transvalvular gradient, can be appreciated by the fact that it takes weeks to months for the pulmonary vascular bed to undergo the process of reversibility, and some patients may already have irreversible pulmonary vascular disease at the time of successful valvotomy.In our study, Doppler echocardiography was used as a primary tool for hemodynamic evaluation. It is considered the current standard of care for evaluating the severity of mitral stenosis and outcomes following a procedure.[17] The correlation between Doppler-derived pressure gradients and invasively obtained hemodynamics has been validated extensively with good agreement in all clinical scenarios.[18] The immediate post-procedural evaluation at 24-48 hours also ensures hemodynamic stability and captures any effect of commissurotomy before any possible recoil or restenosis.[19] An interesting finding of our study is that though 87.5% of our population had a history of rheumatic fever, only 33.33% had undergone secondary prophylaxis. This is a reflection of a larger problem in resource-scarce settings and underlines the need for a comprehensive approach to primary and secondary prevention of rheumatic fever.[20] It is evident that if a robust program is put in place for preventing and managing rheumatic fever, a large number of cases of rheumatic heart disease and subsequent interventions like PBMV can be prevented in future generations.The successful hemodynamic results achieved in our population were made possible in carefully selected patients with favorable valve anatomy, as evident by the inclusion criterion of the Wilkins score. Patient selection is a crucial step in the success of PBMV, with valve anatomy, extent of calcification, and the presence of subvalvular fusion being key determinants of procedural success and the risk of complications.[21] The exclusion of patients with unfavorable anatomy, significant commissural calcification, and other adverse features in our study likely played a role in the excellent results achieved. The long-term durability of PBMV outcomes and freedom from reintervention are dependent on a variety of factors, including the initial adequacy of commissural opening, the extent of valve calcification, the presence of ongoing rheumatic activity, and compliance with antibiotic prophylaxis.[22] Although our study aimed to evaluate the immediate hemodynamic effects of PBMV, a systematic follow-up of these patients would offer important insights into the long-term benefits and predictors of restenosis in our patient population.

Limitations:
The study was limited by its small sample size and single-centre design, which may affect generalizability. Additionally, the absence of long-term follow-up data prevents assessment of the durability of hemodynamic improvement and clinical outcomes beyond the immediate post-procedural period.

Conclusion:
Percutaneous balloon mitral valvotomy (PBMV) significantly reduces the pressure gradient across the mitral valve and pulmonary artery pressure in patients with rheumatic mitral stenosis. This indicates that PBMV is an effective treatment for symptomatic rheumatic mitral stenosis with the right valve structure. The procedure is minimally invasive, making it suitable for areas with high rates of rheumatic heart disease. Future studies could focus on larger groups to assess long-term results and the effects of advanced imaging techniques.

References:

1. 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 Aug 24;377(8):713-722. doi: 10.1056/NEJMoa1603693.
2. Zühlke L, Karthikeyan G, Engel ME, Rangarajan S, Mackie P, Cupido-Katya et al. Clinical Outcomes in 3343 Children and Adults With Rheumatic Heart Disease From 14 Low- and Middle-Income Countries: Two-Year Follow-Up of the Global Rheumatic Heart Disease Registry (the REMEDY Study). Circulation. 2016 Nov 8; 134(19):1456-1466. doi: 10.1161/ CIRCULATIONAHA. 116.02 4769.
3. Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP 3rd, Guyton RA, et al; American College of Cardiology/American Heart Association Task Force on Practice Guidelines. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2014 Jun 10;63(22):e57-185. doi: 10.1016/j.jacc.2014.02.536.
4. Nobuyoshi M, Arita T, Shirai S, Hamasaki N, Yokoi H, Iwabuchi M, et al. Percutaneous balloon mitral valvuloplasty: a review. Circulation. 2009 Mar 3;119(8):e211-9. doi: 10.1161/CIRCULATIONAHA.108.792952.
5. Eid Fawzy M, Shoukri M, Al Sergani H, Fadel B, Eldali A, Al Amri M, et al. Favorable effect of balloon mitral valvuloplasty on the incidence of atrial fibrillation in patients with severe mitral stenosis. Catheter Cardiovasc Interv. 2006 Oct;68(4):536-41. doi: 10.1002/ ccd.20770.
6. Bouleti C, Iung B, Laouénan C, Himbert D, Brochet E, Messika-Zeitoun D, et al. Late results of percutaneous mitral commissurotomy up to 20 years: development and validation of a risk score predicting late functional results from a series of 912 patients. Circulation. 2012 May 1; 125(17):2119-27. doi: 10.1161/ CIRCULATIONAHA. 111.055905.
7. Baumgartner H, Hung J, Bermejo J, Chambers JB, Evangelista A, Griffin BP, et al. Echocardiographic assessment of valve stenosis: EAE/ASE recommendations for clinical practice. Eur J Echocardiogr. 2009 Jan; 10(1):1-25. doi: 10.1093/ejechocard/ jen303.
8. Nishimura RA, Carabello BA. Hemodynamics in the cardiac catheterization laboratory of the 21st century. Circulation. 2012 May 1; 125(17):2138-50. doi: 10.1161/ CIRCULATIONAHA. 111.060319.
9. Cruz-Gonzalez I, Sanchez-Ledesma M, Sanchez PL, Martin-Moreiras J, Jneid H, Rengifo-Moreno P, et al. Predicting success and long-term outcomes of percutaneous mitral valvuloplasty: a multifactorial score. Am J Med. 2009 Jun;122(6):581.e11-9. doi: 10.1016/j.amjmed.2008.10.038.
10. Chandrashekhar Y, Westaby S, Narula J. Mitral stenosis. Lancet. 2009 Oct 10;374(9697): 1271-83. doi: 10.1016/S0140-6736(09) 60994-6.
11. Nunes MC, Tan TC, Elmariah S, do Lago R, Margey R, Cruz-Gonzalez I, et al. The echo score revisited: Impact of incorporating commissural morphology and leaflet displacement to the prediction of outcome for patients undergoing percutaneous mitral valvuloplasty. Circulation. 2014 Feb 25; 129(8):886-95. doi: 10.1161/ CIRCULATIONAHA. 113.001252.
12. Fawzy ME, Fadel B, Al-Sergani H, Al Amri M,

Hassan W, Abdulbaki K, et al. Long-term results (up to 16.5 years) of mitral balloon valvuloplasty in a series of 518 patients and predictors of long-term outcome. J Interv Cardiol. 2007 Feb;20(1):66-72. doi: 10.1111/j.1540-8183.2007.00212.x.
13. Silva VR, de Castro Faria SC, de Azevedo Figueiredo F, Pantalero AN, de Oliveira MA, et al. Rheumatic mitral stenosis: Update in diagnosis and evaluation. Current Treatment Options in Cardiovascular Medicine. 2024 Jul;26(7):207-20.
14. Sharma S, Loya YS, Desai DM, Pinto RJ. Percutaneous mitral valvotomy in 200 patients using Inoue balloon-immediate and early haemodynamic results. Indian Heart J. 1993 May-Jun;45(3):169-72.
15. Kumar AS, Talwar S, Saxena A, Singh R, Velayoudam D. Results of mitral valve repair in rheumatic mitral regurgitation. Interact Cardiovasc Thorac Surg. 2006 Aug; 5(4): 356-61. doi: 10.1510/icvts.2005.121590.
16. Vahanian A, Beyersdorf F, Praz F, Milojevic M, Baldus S, Bauersachs J, et al; ESC/EACTS Scientific Document Group. 2021 ESC/EACTS Guidelines for the management of valvular heart disease. Eur Heart J. 2022 Feb 12;43(7):561-632. doi: 10.1093/eurheartj/ehab395. Erratum in: Eur Heart J. 2022 Jun 1;43(21):2022. doi: 10.1093/eurheartj/ehac051.
17. Remйnyi B, Wilson N, Steer A, Ferreira B, Kado J, Kumar K, et al. World Heart Federation criteria for echocardiographic diagnosis of rheumatic heart disease--an evidence-based guideline. Nat Rev Cardiol. 2012 Feb 28;9(5):297-309. doi: 10.1038/nrcardio.2012.7.
18. Thomas JD, Weyman AE. Doppler mitral pressure half-time: a clinical tool in search of theoretical justification. J Am Coll Cardiol. 1987 Oct;10(4):923-9. doi: 10.1016/s0735-1097(87)80290-5.
19. Song JK, Song JM, Kang DH, Yun SC, Park DW, Lee SW, et al. Restenosis and adverse clinical events after successful percutaneous mitral valvuloplasty: immediate post-procedural mitral valve area as an important prognosticator. Eur Heart J. 2009 May;30(10): 1254-62. doi: 10.1093/eurheartj/ehp096.
20. Carapetis JR, Beaton A, Cunningham MW, Guilherme L, Karthikeyan G, Mayosi BM, et al. Acute rheumatic fever and rheumatic heart disease. Nat Rev Dis Primers. 2016 Jan 14;2:15084. doi: 10.1038/nrdp.2015.84.
21. Ben Farhat M, Ayari M, Maatouk F, Betbout F, Gamra H, Jarra M, et al. Percutaneous balloon versus surgical closed and open mitral commissurotomy: seven-year follow-up results of a randomized trial. Circulation. 1998 Jan 27;97(3):245-50. doi: 10.1161/01.cir. 97.3.245.
22. Hernandez R, Bacuelos C, Alfonso F, Goicolea J, Fernбndez-Ortiz A, Escaned J, et al. Long-term clinical and echocardiographic follow-up after percutaneous mitral valvuloplasty with the Inoue balloon. Circulation. 1999 Mar 30;99(12):1580-6. doi: 10.1161/01.cir.99.12.1580.