

Should we wait until severe pulmonary hypertension develops? Efficacy of percutaneous mitral balloon valvuloplasty in patients with severe pulmonary hypertension: A subgroup analysis of our experience

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Abstract

Background: *The primary goal of this study is to evaluate the immediate and long-term effects of percutaneous mitral balloon valvuloplasty (PBMV) on patients with rheumatic mitral stenosis (MS) complicated with severe pulmonary hypertension (PH).*

Methods: *The study population consisted of 85 patients with MS complicated with severe PH (systolic pulmonary pressure > 75 mm Hg). PBMV was performed with Inoue balloon technique. Clinical and echocardiographic follow-up was scheduled at 6 months and 1 year and yearly thereafter.*

Results: *Mitral valve area (MVA) was increased (pre-PBMV MVA was $1.03 \pm 0.21 \text{ cm}^2$, post-PBMV MVA $1.89 \pm 0.34 \text{ cm}^2$, $p < 0.001$) significantly. The mean and the maximum transmitral pressure gradient significantly decreased (pre-PBMV mean transmitral gradient was $18.47 \pm 6.59 \text{ mm Hg}$, post-PBMV $6.84 \pm 3.84 \text{ mm Hg}$, $p < 0.001$, pre-PBMV maximum transmitral pressure gradient was $27.6 \pm 8.38 \text{ mm Hg}$, post-PBMV $12.68 \pm 4.74 \text{ mm Hg}$, $p < 0.001$). Systolic pulmonary artery pressure (SPAP) significantly decreased (pre-PBMV $89.9 \pm 23.38 \text{ mm Hg}$, post-PBMV $54.5 \pm 14.6 \text{ mm Hg}$, $p < 0.001$). Two patients underwent surgery due to rupture of anterior mitral leaflet. There was no peri-procedural mortality. The procedure time was $29.12 \pm 11.37 \text{ min}$. Follow-up duration was $108.2 \pm 31.4 \text{ months}$. One patient died due to heart failure. One patient underwent re-PBMV and 7 patients mitral valve replacement. At the last follow-up, MVA still remained high ($1.52 \pm 0.34 \text{ cm}^2$) and mean transmitral pressure gradient was low ($9.2 \pm 5.7 \text{ mm Hg}$). SPAP was $56.5 \pm 20.8 \text{ mm Hg}$ which was the same as after PBMV.*

Conclusions: *PBMV in patients with MS with severe PH is an effective therapy with low procedure time. However, it is recommended to perform PBMV before developing severe PH. (Cardiol J 2016; 23, 2: 184–188)*

Key words: mitral valve, pulmonary hypertension, balloon valvuloplasty, long-term results, mitral stenosis

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Introduction

Percutaneous mitral balloon valvuloplasty (PBMV) is an effective therapy in patients with symptomatic mitral stenosis (MS) [1–3]. In addition, PBMV is the best choice for isolated MS with favorable morphology [4]. However, long-term effects of PBMV in high-risk MS patients including severe pulmonary hypertension (PH), low ejection fraction, and severe tricuspid regurgitation have infrequently been evaluated. Maoqin et al. [5] followed up patients with MS complicated mild to severe PH for 24 months. The study has demonstrated that PBMV can improve immediate and long-term outcomes of patients with MS complicated by severe PH despite inferior hemodynamic results [5]. The primary goal of this study was to evaluate the immediate and long-term (at least 5 years) results of PBMV in MS patients with severe PH.

Methods

From 1994 to 2010, a total 85 out of 435 patients were included in the study. The criteria for inclusion in the study were defined as MS (mitral valve area [MVA] $\leq 1.2 \text{ cm}^2$) with symptoms of New York Heart Association (NYHA) functional class II to IV complicated by systolic pulmonary artery pressure (SPAP) above 75 mm Hg. Patients with mitral regurgitation (MR) \geq grade 3, moderate to severe aortic disease (aortic valve area $< 1.5 \text{ cm}^2$ and maximum aortic velocity $> 3.0 \text{ m/s}$, or moderate to severe aortic regurgitation according to echocardiographic assessment including pulsed wave (PW) Doppler mapping technique, jet height/left ventricular outflow tract [LVOT] height and jet area/LVOT area), known coronary artery disease (coronary artery stenosis $> 50\%$), or left atrial thrombus were excluded from the study.

Clinical statuses of all patients were determined by NYHA classification. All patients underwent transthoracic (TTE) and transesophageal (TEE) echocardiographic examination before PBMV. TTE control was performed to evaluate MVA and other parameters 24 h after PBMV. TTE evaluation included Wilkins scoring [6], MVA calculation by both planimetric method (MVA measurement by tracing in the short axis view [7]) and pressure half-time method [8], and MR estimation (graded as none, mild, moderate or severe by color-Doppler semiquantitative method) [9]. Clinical and echocardiographic follow-up was scheduled at 6 months and 1 year and yearly thereafter. Follow-up

Table 1. Baseline characteristics.

Parameters	Study population (n = 85)
Age [years]	34.8 \pm 10
Gender (female)	73 (85.8%)
Wilkins Score	7.89 \pm 2
Ejection fraction [%]	64 \pm 3.16
Sinus rhythm [%]	67 (78.8%)
NYHA class II	8 (9.4%)
NYHA class III	42 (49.4%)
NYHA class IV	35 (41.1%)
Balloon size	26.9 \pm 1.07
Procedure time [min]	29.12 \pm 11.37

NYHA — New York Heart Association

period was planned at least 4 years. PBMV was performed with the Inoue balloon catheter (Toray International America Inc.). Probe patency was searched and used in patients with previous patent foramen ovale as described in the previous study [10]. Ideal balloon size was calculated by the height based formula: Balloon size (mm) = (height of patient in cm/10) + 10.

PBMV was performed by stepwise or single inflation method defined earlier [11]. Hemodynamic measurements were repeated after PBMV. Success of PBMV was defined as post-PBMV MVA $> 1.5 \text{ cm}^2$ or an increase $> 50\%$ relative to the baseline value with no severe MR.

The study was approved by the local ethical committee and all patients gave their informed consent.

Statistical analysis

Statistical analysis was performed using SPSS 10 program. Data are presented as mean \pm standard deviation. A value of $p < 0.05$ was considered significant. Two-paired Student's t test was used for continuous variables and χ^2 tests for categorical variables.

Results

Most of the patients were female (73, 85.8%) with a 34.8 \pm 10 years mean age. Out of all patients, 78.8% with sinus rhythm. Acute procedural success rate was 100% in 85 patients. Mean procedure time (from puncture of the femoral vein to successful PBMV) was 29.12 \pm 11.37 min. More than 90% of the study population had NYHA III–IV functional capacity. Baseline characteristics are displayed in Table 1.

Table 2. Hemodynamic measurements before and after percutaneous balloon mitral valvuloplasty (PBMV).

	Pre-PBMV	Post-PBMV	P
Systolic pulmonary artery pressure [mm Hg]	93.27 ± 18.35	57.09 ± 18.82	< 0.001
Mean pulmonary artery pressure [mm Hg]	57.29 ± 11.46	33.72 ± 12.94	< 0.001
Mean mitral gradient [mm Hg]	23.34 ± 5	4.42 ± 3.21	< 0.001
Pulmonary capillary wedge pressure [mm Hg]	32.43 ± 6.76	13.81 ± 7.53	< 0.001

Table 3. Echocardiographic measurements before and after percutaneous balloon mitral valvuloplasty (PBMV).

	Pre-PBMV	Post-PBMV	P
Ejection fraction [%]	64 ± 3.16	64.8 ± 4.22	NS
Left atrium [cm]	4.73 ± 0.52	4.47 ± 0.5	< 0.001
SPAP [mm Hg]	89.94 ± 23.28	54.58 ± 14.67	< 0.001
MVA (planimetric method) [cm ²]	1.03 ± 0.21	1.89 ± 0.34	< 0.001
MVA (PHT method) [cm ²]	1.04 ± 0.23	1.91 ± 0.33	< 0.001
Mean TG [mm Hg]	18.47 ± 6.59	6.84 ± 3.84	< 0.001
Maximum TG [mm Hg]	27.6 ± 8.38	12.68 ± 4.74	< 0.001

MVA — mitral valve area; NS — non-significant; SPAP — systolic pulmonary artery pressure; PHT — pressure half-time; TG — transmitral gradient

Table 4. Echocardiographic follow-up.

	Pre-PBMV	Post-PBMV	First year	Second year	Last follow-up
MVA (planimetric method) [cm ²]	1.03 ± 0.21	1.89 ± 0.34	1.81 ± 0.3	1.79 ± 0.3	1.53 ± 0.37
Mean transmitral gradient [mm Hg]	18.47 ± 6.59	6.84 ± 3.84	7.0 ± 3.1	8.4 ± 4.3	9.2 ± 5.7
SPAP [mm Hg]	80.94 ± 23.28	54.58 ± 14.67	51.9 ± 17	53.2 ± 20.3	55.7 ± 20.6
Left atrium [cm]	4.73 ± 0.52	4.47 ± 0.5	4.31 ± 0.6	4.39 ± 0.5	4.45 ± 0.54

MVA — mitral valve area; PBMV — percutaneous balloon mitral valvuloplasty; SPAP — systolic pulmonary artery pressure

The mean transmitral pressure gradient, SPAP and mean pulmonary artery pressure (PAP) and pulmonary capillary wedge pressure (PCWP) significantly decreased after PBMV. Details of invasive measurements before and after PBMV is shown in Table 2.

MVA was increased (pre-PBMV MVA was 1.03 ± 0.21, post-PBMV MVA 1.89 ± 0.34 cm², p < 0.001) significantly. The mean and the maximum transmitral pressure gradient significantly decreased (pre-PBMV mean transmitral gradient was 18.47 ± 6.59 mm Hg, post-PBMV 6.84 ± 3.84 mm Hg, p < 0.001; pre-PBMV maximum transmitral pressure gradient was 27.6 ± 8.38 mm Hg, post-PBMV 12.68 ± 4.74 mm Hg, p < 0.001). SPAP significantly decreased (pre-PBMV 80.9 ±

± 23.38 mm Hg, post-PBMV 54.5 ± 14.6 mm Hg, p < 0.001). The echocardiographic data are shown in Table 3 and echocardiographic follow-up in Table 4. Eighty-eight percent of patients were followed at the end of the study. Mitral valve replacement was needed due to severe MR in 2 patients due to rupture of anterior leaflet of mitral valve.

Major adverse cardiac events. Mean follow-up duration was 108.2 ± 31.4 months. Eighty-eight percent of all patients were followed-up successfully. During the follow-up period the events were:

Death. One patient died due to Lutembacher syndrome.

Mitral valve replacement. Seven (8.23%) patients underwent surgical therapy indicated by:

MR in 1, combination of progressive aortic valve disease in 3 and restenosis in 3.

Repeat PBMV: One (1.17%) patient underwent repeated PBMV.

Discussion

Pulmonary hypertension is a frequent complication of MS. The main mechanism responsible for the development of PH is passive retrograde transmission of elevated left atrial-pulmonary venous pressure into pulmonary arterial vasculature. Pulmonary venous hypertension induces reactive pulmonary arteriolar vasoconstriction [12].

Previous studies have shown that successful balloon valvotomy decreased the pulmonary systolic pressure and the pulmonary vascular resistance to normal or near-normal values in patients with mild PH [13–16].

ACC/AHA/ESC guidelines recommend PBMV in symptomatic patients with MS and asymptomatic patients with high PAP (at rest > 50 mm Hg) as well. However, there are limited data about the symptomatic patients complicated with PH. This group of patients is usually accompanied by moderate to severe tricuspid insufficiency with impaired functional capacity and may represent delayed for interventional therapy.

Maoquin et al. [5] compared two groups of patients with PH > 80 mm Hg and < 50 mm Hg according to PAP. These patients were followed for 24 months. In this study, in the group with severe PAP, PAP decreased from 97.8 ± 21.5 mm Hg to 54.8 ± 5.8 mm Hg after PBMV. Maoquin et al. [5] reported good clinical response despite low hemodynamic results.

In our study, SPAP decreased similarly after PBMV from 89.9 ± 23.38 mm Hg to 54.5 ± 14.6 mm Hg. Unlike the previous study, our follow-up period is 108.2 ± 31.4 months. During the follow-up period, PAP decreased immediately after the procedure and made a plateau value. At the end of the follow-up period, the PAP remained high when the MVA was 1.52 ± 0.34 cm². We calculated the value 55.7 ± 20.6 mm Hg at the end.

Cruz-Gonzales et al. [17] studied the effect of pulmonary vascular resistance (PVR) on outcomes of PBMV in 2013. Two hundred and sixty-three of 926 patients had elevated PVR (≥ 4 Woods unit). The mean PAP in patients with elevated PVR was 49.17 ± 13.59 mm Hg pre-procedure and significantly decreased after PBMV (38.24 ± 12.55 mm Hg). They declared that PVR is not an independent predictor of procedural success or long-term

results. Selected patients with rheumatic mitral stenosis might benefit from PBMV despite the presence of elevated pre-procedural PVR. In our study, we did not calculate the PVR, however we used PAP. Hemodynamically, pre-PBMV the mean PAP was 57.29 ± 11.46 mm Hg and 33.72 ± 12.94 mm Hg after procedure, respectively. The mean PAP was significantly higher in our study population. When we evaluated the echocardiographic parameters, pre-PBMV SPAP was 89.94 ± 23.28 mm Hg which was significantly decreased after the procedure (54.58 ± 14.67 mm Hg) and remained high at the last follow-up period (55.7 ± 20.6 mm Hg). Our findings showed that high pre-procedural PAP did not affect the procedural success as stated by results by Cruz-Gonzales et al. [17]. However, at the end of the follow-up period, SPAP remained high. These findings suggest that performing PBMV before high PAP may improve functional capacity. Therefore, we think we should not wait until severe PH developed in patients with rheumatic MS for PBMV. However, larger multicenter studies are needed to clarify this hypothesis.

These results confirm that PAP increases during the natural course of mitral stenosis and becomes irreversible after a certain value. Therefore, we suggest that if PBMV is performed before severe PH develops, it may prevent irreversible changes in the pulmonary vascular bed.

Conclusions

The present study demonstrated excellent immediate results of PBMV in patients with symptomatic MS complicated by severe PH with a lower procedure time. Long-term results were comparable with previous studies. However, we recommended performing PBMV before developing severe PH. Further larger multicenter studies are needed for clarifying this hypothesis.

Conflict of interest: None declared

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