# Redo Percutaneous Mitral Valvuloplasty (Redo PMV) in Patients With Recurrent Mitral Valve Stenosis: Immediate and Early Outcomes

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## Abstract

**Background:** Symptomatic recurrent mitral valve stenosis develops in some patients after Percutaneous Mitral Valvuloplasty (PMV). This study assessed the immediate and early outcomes of redo PMV in patients with recurrent mitral valve stenosis after prior PMV.

**Methods:** Fifty-four patients (40 women and 14 men, mean age of 38±8.2 years) underwent a redo (second) PMV for symptomatic restenosis of mitral valve [with Mitral Valve Area (MVA) < 1.5 $cm^2$]. Redo PMV was performed at 5.8±1.2 years after the initial PMV.

**Results:** In this study, 48 hours after the procedure, there was a substantial increase in MVA by 2-dimensional Echocardiography (GE, Vivid 7) from 1.0±0.2 to 2.2±0.4 $cm^2$ (p<0.001) and a decrease in mean left atrial pressure from 27 ± 5 to 15 ± 4 *mmHg* (p<0.001) and in mean transmitral valve gradient from 15±4 to 2±1 *mmHg* (p <0 .001). Mean pulmonary artery pressure did not change significantly with redo procedure. Good immediate result was achieved in 53 patients (98.15%).

**Conclusion:** Redo PMV can be performed successfully in patients with recurrent mitral valve stenosis following previous percutaneous valvuloplasty.

**Keywords:** Echocardiography, Heart valve diseases, Mitral valve, Mitral valve stenosis

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## Introduction

Treatment of rheumatic mitral valve stenosis has dramatically changed during the last few decades. Before 1984, when Inoue *et al* first described the clinical application of Percutaneous Mitral Valvuloplasty (PMV), surgical mitral commissurotomy was the preferred option for patients who had severe Mitral Stenosis (MS) (1).

Different terminologies have been used for this procedure including Percutaneous Mitral Balloon Valvuloplasty (PMBV) (2), Percutaneous Mitral Commissurotomy (PMC), Balloon Mitral Valvotomy (BMV) (3), and newly Percutaneous Mitral Valvuloplasty (PMV) (4). PMV is an alternative to surgical mitral commissurotomy for patients with mitral stenosis. After the first PMV, the rate of recurrent heart failure or recurrence of symptoms due to recurrent mitral valve stenosis reached to 39% (5-7). Although some of the patients with recurrent mitral valve stenosis currently undergo Mitral Valve Replacement (MVR), it is not known whether these patients may benefit from a repeat PMV or not.

Only a few studies have evaluated results of redo PMV; however, they have showed promising results in specific patients with suitable valve morphology (7-9).

The aim of this study was to evaluate early results of a second PMV (redo PMV) in symptomatic patients with recurrent mitral valve stenosis (history of previous PMV).

## Materials and Methods

### *Patient selection and echocardiographic evaluation*

Fifty four patients (40 women and 14 men, mean age of 38±8.2 years) with symptomatic severe MS (10) and Mitral Valve Area (MVA) < 1.5 $cm^2$ underwent redo PMV at our center (with loss of > 50% of the first gain of MVA after successful initial PMV).

Redo PMV was performed at 5.8±1.2 years after the initial successful PMV.

Baseline clinical and echocardiographic characteristics of the study population are summarized in table 1. All patients presented with Dyspnea on Exertion (DOE) New York Heart Association (NYHA) class I (Table 1). This study involved only patients with pure, isolated, and rheumatic mitral valve stenosis.

Two-dimensional transthoracic echocardiography (GE, Vivid 7) was performed 1 week before and 2 days after the redo PMV by the same operator. Transesophageal echocardiography (by the same operator) was also performed before each procedure to rule out any left atrial thrombus. The patients were considered for redo PMV who had favorable echocardiographic criteria for this procedure.

**Table 1.** Baseline characteristics of the patients who underwent redo PMV

| Variables | Value |
|---|---|
| Age (years) | 38± 8.2 |
| Gender | |
| Male | 14 (26%) |
| Female | 40 (74%) |
| NYHA class | |
| I | 0 (0%) |
| II | 10 (18.52%) |
| III | 34 (62.96%) |
| VI | 10 (18.52%) |
| Rhythm | |
| Sinus | 19 (35.1%) |
| Atrial fibrillation | 35 (64.9%) |
| Severe left ventricular dysfunction | 4 (7.4%) |
| Severe chronic lung disease | 8 (14.8%) |
| Hypertension | 11 (20.3%) |
| Diabetes mellitus | 13 (24% ) |
| Previous cerebrovascular accident | 4 (7.4%) |
| Chronic renal failure | 2 (3.7%) |
| Echocardiographic score >8 | 30(55.5%) |

NYHA : New York Heart Association Functional Class

The echocardiographic score described by Wilkins *et al* (11) was used to assess baseline anatomic features of the mitral valve and a score from 1 (normal) to 4 (severely deformed) was assigned to valvular mobility, thickening, calcifications, and subvalvular thickening.

Exclusion criteria were patients with unsuitable mitral valve morphology (described as a Massachusetts General Hospital [MGH] score ≥ 12), who had history of surgical mitral commissurotomy, the patients with more than moderate mitral, aortic or tricuspid regurgitation or other concomitant valve involvement that needed surgery, patients waiting for

coronary artery bypass surgery and finally patients with significant comorbidity (malignancy) which limited their life expectancy.

### Percutaneous mitral valvuloplasty and hemodynamic study

Transesophageal echocardiography was done before the procedure for detection of clot in the left atrium or left atrial appendage. The redo PMV procedure was performed by the stepwise Inoue technique in all of patients. For selection of the appropriate balloon size, patient's height was used as the measure. Hence, the famous formula of height [*cm*]/10+10 was applied for obtaining the reference size (12,13).

The right femoral vein and right femoral artery access was provided. Two pigtail catheters were inserted in the Right Atrium (RA) and Left Ventricle (LV). LV pressures were recorded, ventriculography was done for determining angiographic severity of mitral regurgitation, and then pigtail catheter was pulled back into ascending aorta as a marker. Dye injection was done in RA and Left Atrium (LA) was appeared in levophase.

For finding a precise transseptal puncture site, first, two imaginary reference lines of (1) the horizontal "M-" line and (2) the vertical "midline" were defined .Then, septal puncture was done at the intersecting point of the horizontal "M-line" and the vertical "midline" (14-16).

Once interatrial septum was punctured, the needle entry into the left atrium was confirmed, first, by contrast injection then by hemodynamics study (Pressure recording).

Then, catheter was advanced forward 2 *cm* into the left atrium, while the needle was withdrawn. Heparin 100 *U/kg* was administered intravenously. The coiled-tip guidewire was inserted into the left atrium, and the balloon was pushed slowly into left atrium over the coiled-tip guide wire to form a large loop with the tip pointing in a 6-7 o'clock direction, medial to the orifice of mitral valve. For crossing mitral valve, the stylet was inserted to the catheter tip and the partially inflated distal balloon was directed toward the mitral orifice, by a counterclockwise rotation.

With the balloon in the left ventricle, the distal portion of the balloon was inflated with a large syringe attached to the proximal portion of the catheter outside the femoral vein, and the balloon was withdrawn against the mitral valve. Then, the remainder of the balloon was inflated, causing enlargement of the mitral orifice.

Complete cardiac catheterization was performed in all cases before and immediately after the procedure. Complete hemodynamic measurement of the right and left heart chambers, including simultaneous left atrial and left ventricular pressure measurements (for invasive study of the mean diastolic pressure gradient across the mitral valve) was performed immediately before and after the valvuloplasty.

Cine left ventriculography was performed before and after the redo PMV to assess the presence and severity of angiographic mitral regurgitation.

Evaluation of patients from the procedural aspect was done by transthoracic echocardiography immediately at the end of procedure as well as 48 hours after the procedure. Immediate echocardiography was done for evaluation of acute or critical complications, but detailed echocardiography and analysis of data were done on the basis of echocardiography of 48 hours later.

MVA was determined through planimetry of the mitral orifice in a 2-dimensional short-axis view early in the diastole. Transmitral pressure half-time method was used in patients who had less than or equal to grade 2 Mitral Regurgitation (MR). MR was graded by color Doppler imaging on a scale of 1+ to 4+, according to the jet extension in the left atrium and also detailed echocardiography principles (10) .Short-term clinical follow-up data were available in all patients for whom redo PMV was performed.

### Definitions

Criteria for procedural success were considered as an increase of ≥ 50% in MVA (Obtained MVA ≥ 1.5 $cm^2$) in absence of major complications. Major complications were described as cardiac tamponade, periprocedural death, more than grade 2/4 MR, and cerebrovascular stroke (7).

### Statistical analysis

Quantitative variables were expressed as mean ± standard deviation. Procedural success was considered as the immediate and early results of redo PMV in terms of a 50% or more increase in mitral valve area and a final mitral valve area ≥ 1.5 $cm^2$, with no regurgitation

>2/4 and without major complications (8).

Continuous data (*e.g.* MVA) were compared with use of the student 2-tailed t-test and discrete data with chi-squared test. Moreover, $p<0.05$ was considered statistically significant.

## Results

In our study group, mean age of subjects was 38±8.2 years with 40 women and 14 men. Thirty five patients (64.9%) had Atrial Fibrillation (AF) rhythm. Percutaneous mitral valvuloplasty (redo procedure) was successfully performed in all patients except one. There was no in hospital death. None of the patients developed cardiac tamponade. One patient underwent urgent mitral valve replacement immediate after PMV procedure, because of the mitral valve rupture.

Except the above case, none of the patients developed severe mitral regurgitation (Grade 3, 4) after redo PMV. There were no severe adverse events such as cerebral embolism and stroke. After the procedure, there was a substantial increment in mean MVA by 2-dimensional echocardiography (planimetry method) from 1.0 ± 0.2 to 2.2 ± 0.4 $cm^2$ ($p<0.001$) and a decrease in mean left atrial pressure from 27 ± 5 to 15 ± 4 *mmHg* ($p<0.001$) and in the mean mitral valve pressure gradient (MPG) from 15±4 to 2±1 *mmHg* ($p<0.001$). Mean pulmonary artery pressure (By invasive estimation) did not change significantly with redo PMV [38 *mmHg* before procedure and 32 *mmHg* after it ($p>0.05$)]. On the basis of accepted definition, procedural success was obtained in 53 patients (98.15%).

The degree of mitral regurgitation by left ventriculography immediately after redo PMV did not show significant difference with degree of mitral regurgitation before procedure (Table 2).

Good immediate results defined as post-PMV mitral valve area ≥1.5 $cm^2$, pulmonary /systemic flow ratio ≤1.5:1 and <2/4 increase in mitral regurgitation were achieved in 53 patients (98.15%). In hospital, clinical course of these 53 patients was excellent (without any in hospital morbidity or complications). The combined events in these 54 patients were no death, but one MVR.

## Discussion

In this cohort study, redo PMV for patients with mitral restenosis after favorable initial PMV provided good results. It was demonstrated that redo PMV can be a safe and satisfactory approach in selected cases with immediate procedural success of 98%, optimal final MVA and low complication rate.

### *Factors involved in recurrent mitral valve stenosis*

Ben-Farhat showed that age, cardiac rhythm, echocardiographic score, and MVA are preprocedural predictors of recurrence. The postprocedural predictors were MVA, mitral valve gradient, mean left atrial pressure and systolic pulmonary artery pressure. Multivariate Cox analysis identified the

**Table 2.** Echocardiographic results of the redo PMV

| Variables | Before redo PMV | Post redo PMV | p value |
|---|---|---|---|
| Doppler measurements: | | | |
| Final MVA ($cm^2$) | 1.0 ± 0.2 | 2.2 ± 0.4 | <0.001 |
| Gain of MVA ($cm^2$) | | 1.2± 0.2 | |
| Mean MPG (*mmHg*) | 15 ± 4 | 2 ± 1 | <0.001 |
| Invasive measurements: | | | |
| Mean left atrial pressure (*mmHg*) | 27 ± 5 | 15 ± 4 | <0.001 |
| Mean MPG ¶ (*mmHg*) | 16 ± 4 | 4 ± 1 | <0.001 |
| Mitral regurgitation | | | |
| 0 | 30(55.6%) | 22(40.7%) | NS * |
| 1 | 22(40.7%) | 26(48.2%) | |
| 2 | 2(3.7%) | 5(9.2%) | |
| 3 | 0(0%) | 0(0%) | |
| 4 | 0(0%) | 1(1.9%) | |

All variables are presented as mean ± SD

* Non-significant

¶ Mean mitral valve pressure gradient

echocardiographic score, MVA before and after PMV, and the mitral valve gradient after PMV as predictors of recurrence (17). Iung *et al* have reported that long term recurrent mitral valve stenosis occurred in 97% of patients with poor functional class (New York Heart Association functional class III or IV symptoms) after PMV (18).

### Treatment approaches for recurrent mitral stenosis after first PMV

PMV is established as a safe and effective technique to relieve rheumatic tight mitral stenosis (19-22). Recurrent mitral valve stenosis is a frequent cause of functional deterioration after an initially successful surgical or balloon commissurotomy. The incidence of restenosis varies widely among centers and techniques. Recurrent symptoms after successful initial PMV have been indicated in 7-21% of patients; however, it is reported to reach 40% during 7 years of follow-up (7,23-25) . In earlier studies, recurrent mitral valve stenosis was defined as a decrease of 50% of the initial gain in MVA .For other investigators, MVA <1.5 $cm^2$ with a loss of 50% of initial gain of MVA must be considered as significant mitral re-stenosis (26-29).

For many years, Mitral Valve Replacement (MVR) has been the main part of invasive therapy in patients with recurrent MS due to prominent valve deformity (7,30). However, owing to high surgical risk besides mortality and morbidity of MVR in short and long term, this way of treatment is significantly replaced with other non-surgical methods, including interventional methods like redo PMV (9). In recent years, redo PMV has been regarded as a remarkable treatment strategy and revolutionized in patients with recurrent MS particularly in those with favorable valve anatomy (9,31,32).

### Immediate outcome after redo PMV

Good immediate procedural success rate of 98.15% was achieved in this study. In a study by Pathan *et al*, an immediate procedural success was obtained in 75% of cases (33). A study by Iung *et al* showed good immediate results in 48 patients (91%) (9). Higher success rate in our cases could be due to favorable patient characteristics like lower age range (38±8.2 years).Young age has been shown as a strong predictor of favorable immediate outcome of PMV (7). In the published study by Bouleti *et al*, the favorable outcome of repeat PMC was particularly demonstrated in patients who were younger than 50 years (34).

The safety of redo PMV (Repeat PMC) has been shown in some studies (34). In our study, urgent surgery (MVR) was needed just in one patient due to mitral valve rupture. Except one case, fortunately, no iatrogenic severe mitral regurgitation was observed after the procedure (redo PMV).

In study by Rifaie *et al* (7), incidence of severe MR after redo PMV was 5 %. Similar to a study by Chmielak *et al* (31), no adverse events such as cerebral embolism and stroke were observed comparing with 3.3% rate in another comprehensive study (7).

### Long-term outcome of redo PMV based on previous studies

In one study, long term follow up showed that in patients with Wilkins score <7, event-free survival rates were significantly better than those who had higher echo score (echo score ≥ 7).They also showed that long-term survival at 8 years in patients with good immediate results was much better than cases without adequate immediate results (31). A recent report demonstrated that ,in group of redo PMV (re-PBMV), ten-year survival rate was significantly higher than surgery group (MVR) (35).

Long-term results of redo PMV were satisfactory according to another study. It was demonstrated that gain of >1.8 $cm^2$ in mitral valve area was effectively correlated with event-free survival rates and also restenosis at five-year follow-up (36).

### Clinical implications

### Limitations

This was a cohort study of selected patients with relatively younger age. Therefore, the same results may not be obtained among older individuals with many comorbid conditions. Moreover, only early outcome after the redo PMV is reported in this study. Longer follow up is needed to evaluate long term consistency of the excellent short-term results. This study was a single center study with great experience in performing PMV. Our low rate of complications may not be achieved in centers with low-volume operators.

## Conclusion

This study suggests that redo PMV in patients with a history of PMV and recurrent
symptomatic mitral valve stenosis is safe and should be the procedure of choice. Though mitral valve surgery should be the treatment of choice for patients with more extensive valvular and subvalvular deformity, redo PMV can be utilized as a good alternative in these patients with high surgical risk for mitral valve surgery.

## Conflict of Interest

Authors have no conflict of interest to disclose.

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