Impact of Successful Balloon Mitral Valvotomy on the Severity of Functional Tricuspid Regurgitation in Patients with Rheumatic Mitral Stenosis

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Abstract

Background: Significant rheumatic mitral stenosis is frequently associated with functional tricuspid regurgitation (TR) and when it is severe it adversely impact morbidity and mortality in patients undergoing mitral valve surgery. However, the effect of successful balloon mitral valvotomy (BMV) on significant TR is not fully established, so we sought to evaluate the effect of BMV on the severity of associated functional TR.

Methods: This study included 46 consecutive patients with moderate-severe rheumatic mitral stenosis (valve area <1.5cm$^2$), and at least moderate pre-procedural functional TR (≥ grade II/IV) by Doppler echocardiography, who had been underwent successful BMV by either Inoue or multi-track system at our center. Post-procedural Doppler echocardiography was performed at hospital discharge, 3 months, and 18 months later.

Results: Significant regression of TR (≥ 1 grade) was reported in 24 (31%) patients at 3 months follow-up with no further significant regression at 18 months. There was a parallel reduction in pulmonary artery systolic pressure (PASP) starting immediately after the procedure and continued through 18 months (from 64±22 to 25±14mmHg, p<.002). Predictors of significant TR regression in this study included: Younger age, higher preprocedural PASP, absent atrial fibrillation, and larger post-procedural mitral valve area.

Conclusions: In patients with moderate-severe symptomatic rheumatic mitral stenosis and significant functional TR, successful BMV could lead to significant regression of TR severity paralleled with reduction in PASP.

Key Words: Balloon mitral valvotomy – Tricuspid incompetence – Pulmonary hypertension.

Introduction

SIGNIFICANT tricuspid valve regurgitation (TR) is a common finding in patients with severe mitral stenosis, and in the majority of cases, it is functional, resulting from right ventricular and tricuspid annular dilation caused by long standing pulmonary hypertension. Significant TR in this situation is occasionally associated with an adverse impact on morbidity and mortality in patients undergoing mitral valve surgery [1,2].

TR in the setting of mitral valve disease is expected to regress after replacement of the diseased mitral valve. Although earlier reports suggested that TR can resolve once the diseased mitral valve is replaced, [1,2] the results of later studies are contradictory [3,4].

Percutaneous balloon mitral valvotomy (BMV) has proved to be an effective technique for the relief of obstruction in patients with mitral stenosis. Several studies reported the immediate responses of pulmonary artery pressure to BMV [5,6]. However, the long-term effects of this technique on the associated TR have not been extensively studied [7]. Accordingly, the purpose of this study was to evaluate the effect of successful BMV on the severity of associated functional TR and PASP at 18 months follow-up.

Material and Methods

Data were analysed from 46 patients with symptomatic moderate-severe rheumatic mitral stenosis (mitral valve area <1.5cm$^2$) with at least grade II/IV functional TR who underwent successful BMV.

Procedure: All procedures were performed by the anterograde trans-septal approach. An Inoue balloon system was used in 34 (75%) patients, and the multi-track system in 12 (25%) patients, according to the standard stepwise technique, and under echocardiographic guidance. Contraindications to BMV were: Severe calcification of both commissars, left atrial thrombus on transesophageal
Echocardiography, and mitral regurgitation of grade ≥II/IV. A successful immediate result was considered with doubling of the preprocedural mitral valve area (MVA) or absolute post-procedural MVA ≥ 1.5 cm² (whichever larger) with no regurgitation ≥II/IV [8].

Echocardiography. Two-dimensional and color Doppler echocardiographic examination was performed before BMV, immediately after the procedure, predischarge from hospital and at 3 and 18 months follow-up, using commercially available equipment (Hewlett-Packard Unit Sonos 2500) and standard techniques.

TR was assessed by Doppler color flow mapping of the regurgitant jet. Careful Doppler evaluation of the jet was performed in all obtainable views of the right ventricle and atrium, including the parasternal short-axis view at the aortic valve level, the right ventricular inflow view, the apical 4-chamber view, and subcostal views. The color flow mapping display of reversed or mosaic signals originating from the tricuspid valve and extending into the right atrium during systole identified the presence of TR. The area of disturbed flow that was traced included the aliased signals as well as the immediately contiguous non-turbulent velocities that were moving in the same direction as the jet. Right atrial area was traced from the same frame as the maximal jet area. The severity of regurgitation was graded as grade I if the regurgitant jet area occupied ≤20% of the right atrial area, grade II if this value was between 20% and 30%, grade III if this value was between 30%-40%, and grade IV if it was >40% [9-11]. TR was defined as organic if thickening, doming, or restricted motion of the valve leaflets were present. Patients with organic TR were excluded from the study. Significant regression in TR was considered with at least one grade reduction in TR severity [12].

The right ventricular systolic pressure was estimated by continuous wave Doppler, using the modified Bernoulli equation (4 X [peak TR velocity]²), with 10 mmHg added for the estimated right atrial pressure. The right ventricular systolic pressure was considered to be equal to the PASP unless there was pulmonary stenosis [9].

The right ventricular end-diastolic diameter was measured from the septum to the free right ventricular wall at the mid-cavitary level in end-diastolic frames.

Clinical follow-up: Patients were assessed at the same sitting of the echocardiographic follow-ups for heart failure symptoms (assessed by NYHA functional class). Other clinical endpoints included death, cerebral strokes, repeat BMV; and mitral valve replacement.

Statistical analyses: The statistical analyses were performed with the use of commercially available software (SAS version 8 of Statistical Analysis System, SAS Institute Inc, Corp, Cary, NC). The over-time changes from baseline to follow-up were evaluated by the paired Student t test for continuous variables. Baseline clinical, echocardiographic, and hemodynamic characteristics were examined with multivariate regression analysis to determine their predictive value for reduction in TR. All results are expressed as mean ± SD. Differences were significant at a value of p<0.05.

Results

Baseline characteristics:

The mean age of the patients was 28 ± 9 years (range 22 to 41 years), 40 (86%) were females, and 33 (72%) were in AF. Most of the patients were in NYHA functional class III/IV. A previous commissurotomy had been performed in 2 (3%) patients. In all patients, 9 (19%) had grade II/IV TR, 24 (53%) had grade III/IV and 13 (28%) had grade IV. The mean PASP was 64 ± 22 mmHg. The baseline pulmonary artery systolic pressure measured invasively at the procedure time was found to be highly correlated to the Doppler value (r=0.67). Baseline characteristics of the study population are summarized in Table (1).

Immediate changes after percutaneous BMV:

BMV was considered successful in all patients; resulting in a significant increase in mitral valve area (from 0.92 ± 0.31 to 1.72 ± 0.46 cm², p<0.001), with a significant decrease in mean transmirtal diastolic gradient (from 11 ± 6 to 6 ± 4 mmHg, p<.05). Immediately after the procedure, PASP decreased significantly (from 64 ± 22 to 45 ± 9 mmHg, p<0.002), while TR severity did not change significantly. Significant mitral incompetence (≥grade II/IV) were induced in 5 (11%) patients. Significant ASD (>5 mm) was detected in 1 (2%) patient.

Long-term results:

TR: At 3-month follow-up the regurgitant jet area decreased significantly from 5.5 ± 3.2 to 3.2 ± 2.8 cm², p<.001. Significant regression in TR severity (≥1 grade) was noted in 31 (67%) with no further significant regression in TR severity by 18 months (Table 2, and Fig. 1). Using multivariate regression analysis; younger age, higher preprocedural PASP, absent atrial fibrillation, and larger post-procedural
mitral valve area were all significant predictors of significant regression in TR severity.

**PASP:** At 3-month follow-up; significant drop in PASP as compared with the immediate results was reported (from 45±9 to 30±12mmHg, p<0.001). All patients with significant drop in PASP showed significant regression of TR severity at 3-month follow-up. At 18-month follow-up; further drop of PASP was reported (from 30±12 to 25±14mmHg, p<0.05) (Table 2). Normalization of PASP (<30 mmHg) was achieved in 14 (31%) patients. Predictors of drop in PASP were the same predictors of TR regression (younger age, higher preprocedural PASP, absent atrial fibrillation, and larger post-procedural mitral valve area).

**RV dimensions:** Significant reduction in the RV end-diastolic dimension paralleled the drop in PASP at 18-month follow-up (from 28±6 to 21±11 mm, p<.002).

**Clinical outcome:** Significant improvement in the functional status (by ≥one NYHA class) was observed in 44 (95%) patients at 3-month follow-up. At 18-month follow-up 32 (70%) patients were in NYHA class I and 14 (30%) patients in NYHA class II. One patient had underwent mitral valve replacement for procedure-induced severe mitral regurgitation.

Table (1): Clinical characteristics of the study population.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tr>
<td>Age (years)</td>
<td>28±9 years</td>
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<tr>
<td>Sex (Females)</td>
<td>40 (86%)</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>33 (72%)</td>
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<td><strong>Baseline NYHA class:</strong></td>
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<tr>
<td>Class II</td>
<td>4 (8%)</td>
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<td>Class III</td>
<td>33 (72%)</td>
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<td>Mitral valve area (cm²)</td>
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<tr>
<td><strong>TR:</strong></td>
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<tr>
<td>Grade II</td>
<td>9 (19%)</td>
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<td>24 (53%)</td>
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<td>Grade IV</td>
<td>13 (28%)</td>
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<tr>
<td>PASP (mmHg)</td>
<td>64±22</td>
</tr>
<tr>
<td>RV end-diastolic diameter (mm)</td>
<td>28±6</td>
</tr>
</tbody>
</table>

NYHA: New York Heart Association; TR: Tricuspid regurgitation; PASP: Pulmonary artery systolic pressure; RV: Right ventricle.

**Discussion**

Although earlier reports suggested that TR can resolve once the diseased mitral valve is replaced [1,2] the results of later studies are contradictory [12,13]. This study was designed to determine the impact of successful BMV on the severity of concomitant functional TR in patients with moderate-severe rheumatic mitral stenosis and clinically indicated BMV.

This study showed that successful BMV could lead to significant regression in the severity of TR that parallels the drop in the PASP. Similarly Breyer and Song showed regression of significant TR after successful BMV in relatively young patients (mean age 25±10 years) with severe MS and concomitant significant pulmonary hypertension (70±22mmHg) [4,14]. On the other hand, Sagie et al. reported no regression of TR in relatively older patients (mean age 57±15 years) with severe MS and mild pulmonary hypertension (46±15mmHg) [15].
Shafie et al. [13] found that despite successful closed commissurotomy for severe mitral stenosis in 8 of their patients with initially severe TR, no improvement in TR was observed at 1-year follow-up. Repeat catheterization in 4 of these patients for persistent right ventricular failure demonstrated an adequate mitral valve area and good left ventricular function but persistent severe TR. One of the potential mechanisms for their observations was persistently elevated PASP, which maintains the driving pressure for TR and could also play a role in maintaining the right ventricular and tricuspid annular dilation.

In the current study older patients and patients with atrial fibrillation were less likely to have significant regression of TR and PASP. The same observation was reported by Sagie et al. who studied 32 patients with different demographic characteristics from ours; being much older (age, 57 ± 15 years), and had very high prevalence of atrial fibrillation (75%) and their results showed failure of TR regression in these patients subgroup [15]. This is understandable as older age and atrial fibrillation both are associated with more advanced and possibly irreversible pathophysiological changes at the level of pulmonary vasculature leading to persistence of pulmonary hypertension and failure of TR regression [16].

Recoil of the tricuspid annulus after BMV may take sometime even after drop in PASP. This could explain the time lag between the procedure and the regression in TR severity (observed by 3 month) in the current study, while significant drop in PASP was reported immediately after the procedure [17,18].

In this study no further significant regression in TR was observed after the first 3 months despite continuing drop in PASP at 18 month. This observation was not reported in any of the available studies, and it could suggest a maximum for the recoil of the tricuspid annulus that cannot be exceeded by further drop in PASP. However, because of the small sample size of this study we suggest investigating this observation on a larger population scale.

**Conclusion:**

In patients with moderate-severe symptomatic rheumatic mitral stenosis and significant functional TR, successful BMV could lead to significant regression of TR severity paralleled with reduction in PASP. Younger age, higher preprocedural PASP, absent atrial fibrillation, and larger post-procedural mitral valve area are all predictors of TR regression in these patients.

**References**


