Percutaneous mitral valvotomy versus closed surgical commissurotomy. Up to 15 years of follow-up of a prospective randomized study

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KEYWORDS
Mitral valve stenosis; Valvuloplasty; Follow-up studies

SUMMARY
Background: Immediate and intermediate term results of percutaneous mitral valvotomy (PMV) are comparable to closed surgical commissurotomy (CSC). We aimed at exploring this relation in the long term.

Methods: Previously, we randomized 40 consecutive patients with moderate to severe mitral stenosis [defined as mitral valve area (MVA) less than 1.5 cm²] to undergo either PMV (PMV group = 20 patients) or CSC (CSC group = 20 patients). For all patients, full echocardiographic assessment was performed before the procedure/operation. Patients assigned to PMV underwent the double balloon technique. Echocardiographic assessment was done following both procedures before discharge and repeated 1 and 6 months later. Echocardiographic follow-up was performed, thereafter, on a yearly basis for up to 15 years, with a mean follow-up period of 99 ± 12 months.

Results: Immediate echocardiographic results showed no statistically significant difference between the 2 groups regarding the final MVA or mean diastolic pressure gradient across the mitral valve. Two patients dropped out from the CSC group and one from the PMV group. MVA was 1.8 ± 0.3 cm² versus 1.8 ± 0.4 cm² (p > 0.05) and mean diastolic pressure gradient across the mitral valve was 7 ± 4 mmHg versus 6.6 ± 4 mmHg (p > 0.05) in the PMV and CSC groups, respectively.

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Introduction

During the past 15 years, percutaneous mitral valvotomy (PMV) has emerged as the procedure of choice in most patients with symptomatic mitral stenosis [1]. Large series have observed a promising outcome both in the short and intermediate term [2–6], in addition to a low incidence of serious complications [7]. Furthermore, in patients with a mitral valve morphology suitable for balloon valvotomy, prospective randomized trials comparing PMV with surgical mitral commissurotomy (both open and closed) have reported similar clinical, echocardiographic, and hemodynamic results between the two treatment modalities, added to a shorter period of hospitalization and less mortality and morbidity in patients assigned to PMV [8–11]. Moreover, PMV can still be an option for severely degenerated and deformed valves, as palliative treatment in elderly patients with high surgical risk [12,13].

Nevertheless, few data exist about long-term follow-up results of PMV in comparison to closed surgical commissurotomy (CSC) [11,14,15]. We sought to explore long-term (up to 15 years) follow-up results of a prospective randomized study comparing PMV and CSC in a series of patients with rheumatic moderate to severe mitral stenosis.

Patients and methods

Population

Previously, we enrolled 40 consecutive patients with moderate to severe mitral stenosis [defined as mitral valve area (MVA) less than 1.5 cm²] admitted to our center during the period from September 1988 to March 1990, suffering from pulmonary congestion symptoms. Patients were considered eligible for enrollment if they had no more than grade 2/4 mitral regurgitation (MR) and minimal or mild mitral valve calcification by echocardiography. We excluded patients with previous PMV, previous surgical mitral commissurotomy, those with thrombi in the left atrial cavity, those with history of prior systemic embolization, those with concomitant valve disease that needed surgical intervention, those indicated for coronary artery bypass surgery, and those with limited life expectancy due to coexistent disease (for example, malignancy). Before inclusion, informed consent was obtained from each patient and the study protocol was reviewed and approved by our local institutional human research committee as it conforms to the ethical guidelines of the 1975 Declaration of Helsinki.

Methods

After enrollment, patients were randomly assigned to undergo either PMV (PMV group = 20 patients) or CSC (CSC group = 20 patients). Assessment of all patients by trans-thoracic echocardiography was performed within 24 h after admission. Doppler echocardiography was performed using a Hewlett Packard Sonos 1000 cardiac ultrasound machine (Hewlett Packard, Andover, MA, USA). A 2.5 MHz phased array probe was used to obtain standard 2D and Doppler images. Patients were examined in the left lateral recumbent position using standard parasternal and apical views. MVA was assessed by both planimetry method in the parasternal short axis view, and pressure halftime (PHT) method in the apical 4-chamber view. Mean diastolic pressure gradient across the MV was measured from Doppler spectral analysis of diastolic mitral flow in the apical 4-chamber view. Semi-quantification of MR grade was obtained by color flow mapping of MR jet using Helmcke classification [16]. Scoring of the mitral valve was done by the Massachusetts General Hospital (MGH) scoring system (total score expressed out of 16) [17] that includes scoring values for mitral valve leaflet thickness (0–4), mobility restriction (0–4), calcification (0–4), and subvalvular affection (0–4), each expressed out of 4. Left atrial diameter was measured in parasternal long and short-axis views. Other chamber size was also assessed as well as other valve abnormalities.

Patients in atrial fibrillation received oral anticoagulants for 6 weeks before the proce-
dure/operation aiming at an international normalized ratio (INR) 2–3, to minimize the risk of embolization. Oral anticoagulants were stopped for several days before the procedure/operation until the INR decreased below 1.5. PMV was performed by the standard double balloon technique based on the method described by Al Zaibag et al. [18] and modified by Palacios in 1987 [19]. Balloon size was chosen according to mitral annular diameter as follows: sum of diameters of the two balloons equals mitral annular diameter. Right and left heart hemodynamic data were recorded before and after the procedure. CSC operation was performed through a left thoracotomy incision. Tubb’s dilator was opened to a maximum of 2.5 cm in females and 3.5 cm in males.

Patient assessment by trans-thoracic echocardiography was repeated 48 h following PMV, and within 1 week following CSC, to evaluate final MVA (by both planimetry and PHT methods), mean diastolic pressure gradient across the mitral valve, and the presence and grade of MR, if any. Residual atrial septal defect was evaluated in patients who underwent PMV, by pulsed wave Doppler in the subcostal 4-chamber view.

Follow-up

Clinical and echocardiographic follow-up was performed 1 and 6 months following either procedure, and then annually for up to 15 years. Echocardiographic follow-up was done using the same cardiac ultrasound machine (Hewlett Packard Sonos 1000, Hewlett Packard). Evaluation included assessment of MVA (by both planimetry and PHT methods), mean diastolic pressure gradient across the mitral valve, and the presence and grade of MR, if any. Residual atrial septal defect was evaluated in patients who underwent PMV.

Definitions

Procedural/operation success was defined as an increase of 25% or more of MVA (measured by PHT method) with a final MVA equal to or more than 1.5 cm². Suboptimal result was defined as final MVA less than 1.5 cm² and/or less than 25% increase of MVA (measured by PHT method). Restenosis was defined as a decrease of 50% or more of the final MVA (measured by PHT method) obtained immediately following either procedure.

Statistical analysis

All continuous variables were presented as mean ± S.D., if they were normally distributed. Differences in the normally distributed variables were assessed using the t-test and the paired t-test for dependent variables. Categorical variables were described with absolute and relative (percentage) frequencies. Pearson \( \chi^2 \) and un-paired t-tests were used to compare the distribution of categorical and continuous variables, respectively, between the two individual study groups. All tests were two-sided and a probability value of \( p < 0.05 \) was considered statistically significant. Finally, Kaplan–Meier curves were constructed to depict survival free from restenosis in both the PMV and CSC groups. Analyses were performed with SPSS version 12.0 statistical package (SPSS Inc., Chicago, IL, USA).

Results

A total of 40 consecutive patients with moderate to severe mitral stenosis were included in the current study. The mean age of the study population was 29.7 ± 7 years, 70% (28 patients) being females. Six patients (15%) were in atrial fibrillation. Table 1 shows baseline clinical characteristics and initial echocardiographic findings of the 2 individual study groups. No statistically significant difference was found between the two groups concerning any of the baseline clinical or initial echocardiographic characteristics.

Immediate results

Table 2 shows the immediate echocardiographic results in both groups. No statistically significant difference was found between the 2 groups regarding the final MVA or mean diastolic gradient across the mitral valve. Suboptimal results occurred in 3 patients in the PMV group, 2 of whom had significant subvalvular fibrosis and crossed to the other group (CSC group) to undergo CSC, however, only 1 of them had an optimal result after surgery. Among the CSC group, only 1 patient had a suboptimal result. New MR developed in 2 patients in both groups (10%). One patient (5%) in the PMV group developed hemiplegia, and 3 (15%) developed left-to-right shunt (all had \( Q_p/Q_s \) below 1.4) as assessed by oxymetry. Among the CSC group, 1 patient (5%) developed wound infection and another (5%) developed mild pericardial effusion.

Long term follow-up

Patients in both groups underwent clinical and echocardiographic follow-up, on a yearly basis, for up to 15 years, with a mean follow-up period of
Table 1  Baseline clinical characteristics and initial echocardiographic findings of the 2 individual study groups

<table>
<thead>
<tr>
<th></th>
<th>PMV group (N = 20)</th>
<th>CSC group (N = 20)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>26±9</td>
<td>25±8</td>
<td>n.s.</td>
</tr>
<tr>
<td>Females</td>
<td>13 (65)</td>
<td>15 (75)</td>
<td>n.s.</td>
</tr>
<tr>
<td>AF</td>
<td>3 (15)</td>
<td>3 (15)</td>
<td>n.s.</td>
</tr>
<tr>
<td>NYHA Class</td>
<td></td>
<td></td>
<td>n.s.</td>
</tr>
<tr>
<td>Class I</td>
<td>1 (5)</td>
<td>1 (5)</td>
<td>n.s.</td>
</tr>
<tr>
<td>Class II</td>
<td>15 (75)</td>
<td>13 (65)</td>
<td>n.s.</td>
</tr>
<tr>
<td>Class III</td>
<td>4 (20)</td>
<td>6 (30)</td>
<td>n.s.</td>
</tr>
<tr>
<td>Class IV</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>n.s.</td>
</tr>
<tr>
<td>MVA by PHT (cm²)</td>
<td>0.9 ± 0.3</td>
<td>1 ± 0.2</td>
<td>n.s.</td>
</tr>
<tr>
<td>MVA by 2D (cm²)</td>
<td>0.9 ± 0.4</td>
<td>1.1 ± 0.3</td>
<td>n.s.</td>
</tr>
<tr>
<td>Mean DPG (mmHg)</td>
<td>17 ± 7</td>
<td>15 ± 6</td>
<td>n.s.</td>
</tr>
<tr>
<td>MGH score</td>
<td>5.8 ± 2.1</td>
<td>6 ± 2.1</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

All continuous variables are presented as mean±S.D., while categorical variables are presented as numbers (percentage). PMV: percutaneous mitral valvotomy; CSC: closed surgical commissurotomy; AF: atrial fibrillation; NYHA: New York Heart Association; MVA: mitral valve area; PHT: pressure halftime; 2D: two-dimensional echo; DPG: diastolic pressure gradient; MGH: Massachusetts General Hospital.

Table 2  Immediate echocardiographic results following the procedure in the 2 individual study groups

<table>
<thead>
<tr>
<th></th>
<th>PMV group (N = 20)</th>
<th>CSC group (N = 20)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVA by PHT (cm²)</td>
<td>2 ± 0.05</td>
<td>2.1 ± 0.05</td>
<td>n.s.</td>
</tr>
<tr>
<td>MVA by 2D (cm²)</td>
<td>1.8 ± 0.4</td>
<td>1.6 ± 0.4</td>
<td>n.s.</td>
</tr>
<tr>
<td>Mean DPG (mmHg)</td>
<td>6 ± 3</td>
<td>6 ± 4</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

Continuous variables are presented as mean±S.D., while categorical variables are presented as numbers (percentage). PMV: percutaneous mitral valvotomy; CSC: closed surgical commissurotomy; MVA: mitral valve area; PHT: pressure halftime; 2D: two-dimensional echo; DPG: diastolic pressure gradient.

99±12 months. Two patients dropped out from the CSC group and 1 from the PMV group. Clinically, all patients were in NYHA class I, except for the 2 patients with suboptimal results after PMV (1 of them crossed to the CSC group), and 1 who had a suboptimal result after CSC. In the long term, MVA (measured by PHT method) was 1.8±0.3 cm² in the PMV group versus 1.8±0.4 cm² in the CSC group (p>0.05) (Table 3). Mean diastolic pressure gradient across the mitral valve was 7±4 mmHg in the PMV group versus 6.6±4 mmHg in the CSC group (p>0.05). In 2 patients who developed new MR following PMV, MR grade decreased from 2/4 to 1/4 in 1, and remained 1/4 in the other; meanwhile, in the CSC group, MR grade decreased from 2/4 to 1/4 in 1 patient and disappeared in another who initially developed grade 1/4 MR. New atrial fibrillation developed in 3 (15.8%) patients in the PMV group and in 4 (22.2%) patients in the CSC group (p>0.05). Mitral restenosis occurred in 5 (26.3%) patients in the PMV group versus 5 (27.8%) patients in the CSC group (p>0.05). PMV was repeated in 2 out of 5 patients with restenosis following initial PMV procedure. No mortality was noted during the follow-up period. Kaplan—Meier curves for restenosis-free survival showed no difference between the two groups (log-rank = 0.1; p>0.05) (Fig. 1). Left-to-right shunt disappeared

Table 3  Long term follow-up data in the 2 individual study groups

<table>
<thead>
<tr>
<th></th>
<th>PMV group (N = 19)</th>
<th>CSC group (N = 18)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVA by PHT (cm²)</td>
<td>1.8±0.3</td>
<td>1.8±0.4</td>
<td>n.s.</td>
</tr>
<tr>
<td>Mean DPG (mmHg)</td>
<td>7±4</td>
<td>6.6±4</td>
<td>n.s.</td>
</tr>
<tr>
<td>Restenosis</td>
<td>5 (26.3)</td>
<td>5 (27.8)</td>
<td>n.s.</td>
</tr>
<tr>
<td>New AF</td>
<td>3 (15.8)</td>
<td>4 (22.2)</td>
<td>n.s.</td>
</tr>
</tbody>
</table>

Continuous variables are presented as mean±S.D., while categorical variables are presented as numbers (percentage). PMV: percutaneous mitral valvotomy; CSC: closed surgical commissurotomy; MVA: mitral valve area; PHT: pressure halftime; DPG: diastolic pressure gradient; AF: atrial fibrillation.
in 2 out of 3 patients who developed the condition after PMV, and persisted in 1 at 7 years of follow-up.

Discussion

The results of the current study represent the long-term follow-up data of a prospective randomized study comparing the safety and efficacy of PMV procedure versus CSC operation for treatment of patients with moderate to severe rheumatic mitral stenosis. To our knowledge, it presents the longest period of follow-up reported to date in these patients (up to 15 years with a mean ± S.D. of 99 ± 12 months).

Both procedures achieved a satisfactory MVA even at long-term follow-up (1.8 ± 0.3 cm² in the PMV group versus 1.8 ± 0.4 cm² in the CSC group), and credibly a similar mean diastolic trans-mitral pressure gradient (7 ± 4 mmHg in the PMV group versus 6.6 ± 4 mmHg in the CSC group). Restenosis rates were also comparable between the two treatment modalities (25% and 27%) at up to 15 years of follow-up, similar to previous observations [8,11,20–22].

One interesting finding is the decrease, or even disappearance of MR at long-term follow-up, in both patient groups. Commisural splitting is the chief mechanism by which MVA is increased during the procedure of PMV [23,24]. The regression of MR at follow-up might be explained by gradual healing of over-split commissures or recovery of papillary muscle function. Similar regression of MR following PMV was also reported by Palacios et al. [3]. Comparably, another study found satisfactory long-term outcome following PMV even in patients with unilateral commissural calcification with no significant difference from those without commissural calcification [25].

Despite earlier reports that left-to-right shunt disappears on follow-up [3,26], we did notice its persistence in 1 patient at 7 years of follow-up. However, the shunt was small, hemodynamically insignificant, and this patient had MVA of 1.8 cm² at follow-up.

The appearance of new cases of atrial fibrillation in both groups at follow-up highlights the impact of rheumatic affection of the heart and its progression with time.

Despite the presence of some randomized studies comparing PMV and surgical commissurotomy [8,9,11,20–22], long term follow-up data are scanty. Farhat et al. reported the results of PMV versus both open and closed surgical commissurotomy at 7-years follow-up. They observed that PMV was as effective as open surgical commissurotomy, both being superior to CSC regarding their immediate results and long-term follow-up [11]. However, they reported that in their CSC cohort, successful splitting of both commissures of the mitral valve occurred in only 66% of their patients. Their immediate hemodynamic data revealed an increase in MVA of only 0.7 cm² (versus 1.3 cm² in the PMV group), as well as residual restenosis rate of 27%. Additionally, their immediate echocardiographic data supported these differences reporting an increase of MVA from 0.9 ± 0.2 cm² to 2.1 ± 0.5 cm² in the PMV group versus an increase from 0.9 ± 0.2 cm² to 1.6 ± 0.3 cm² in the CSC group [11]. It seems that their inferior long-term follow-up results of CSC were due to lower immediate technical success rate and much higher residual stenosis rate. Our study presents the longest follow-up reported to date in this patient category. We observed similar long-term restenosis rates between PMV and CSC procedures (26.3% and 27.8%, respectively) at an average follow-up period of 8.3 ± 1 years which compares well with figures reported in literature both on short [27] and intermediate-term follow-up [28]. It is expected that the results of PMV will be sustained for longer periods of follow-up by extrapolation from CSC long-term data [15].

In our study, all patients in the PMV group underwent the double balloon technique. One comparative study previously reported that compared with the Inoue technique, the double balloon technique results in larger MVA and a lesser degree of severe MR after PMV. However, there were no signif-
The fact that 2 patients with severe subvalvular disease in the PMV group crossed to the CSC group (1 of them had suboptimal results even after CSC) highlights the importance of subvalvular affection in determining the outcome after either procedure. Several reports addressed the issue that subvalvular affection predicts poor outcome after PMV as well as valve-related morbidity and mortality were significantly lower after open commissurotomy.

In a follow-up of patients undergoing percutaneous mitral balloon valvotomy, the PMV group demonstrated significantly higher MVA and a greater increase in cardiac index compared to CSC. The clinical follow-up of patients undergoing percutaneous mitral commissurotomy in a series of 528 patients and analysis of predictive factors. J Am Coll Cardiol 1996;27:407–14.

Conclusion

PMV achieves comparable results to CSC both in the short and long term. The achieved good results of PMV are likely to be sustained for up to 15 years of follow-up, remaining similar to CSC.

Limitations of the study

Our findings are based on a single center study with a relatively small sample size, a fact that makes it difficult to generalize our results to all patients with mitral stenosis. Multicenter studies using the same protocol and examining a larger number of patients are needed. Moreover, all our patients underwent PMV with the double balloon technique, and it is unknown whether our data can be safely extrapolated to patients undergoing Inoue PMV and patients undergoing percutaneous metallic valvotomy.

Acknowledgments

This follow-up report was presented as an abstract “oral presentation” in the TCT congress in October 2006, Washington, DC, USA, being chosen as one of the best 5 abstracts in the congress. It was also presented as an abstract “poster presentation” in the Conjoint Congress of the European Society of Cardiology and World Echocardiography Congress of August 2006, Barcelona, Spain being included in the highlights of the congress.

References


