Original Articles: Clinical Science

Immediate Effects of Increase in Mitral Valve Area on Transvalvular Gradient and pulmonary Artery Pressure after Balloon Mitral Valvuloplasty in Patients with Mitral Stenosis
(Running title : Balloon mitral valvuloplasty)

Shahram Homayounfar MD [1], Maryam Esmaeilzadeh MD [2],
Behshad Naghshtabrizi MD[3*]

Abstract

Aims: The purpose of this study was to determine whether there is any association between the optimal increase in mitral valve area and mitral transvalvular gradient decrement and pulmonary arterial pressure decrement after balloon mitral valvuloplasty (BMV) in patients with mitral stenosis.

Methods: The study population consisted of 49 patients (47 women, 2 men; mean age = 43.7 ± 13.35 years) with symptomatic rheumatic mitral stenosis who underwent balloon mitral valvuloplasty. Optimal immediate outcome of BMV is defined as a valve area increment of 50% or more or a final mitral valve area of ≥1.5 cm^2 and mitral regurgitation Sellers' grade ≤ 2. Mitral valve area, mitral transvalvular peak pressure gradient, mitral transvalvular mean pressure gradient, and pulmonary arterial pressure were measured before and 24-48 hours after balloon mitral valvuloplasty, and differences were compared between patients with successful and unsuccessful optimal outcomes.

Results: There was a direct relationship between mitral valve area enhancement and amount of reduction in mitral transvalvular peak and mean pressure gradient and pulmonary arterial pressure.

Conclusion: After BMV, mitral transvalvular peak pressure gradient, mitral transvalvular mean pressure gradient, and pulmonary arterial pressure reduction were significantly higher in patients with optimal outcome compared with those with suboptimal outcome. (*Iranian Heart Journal 2012; 13 (2):6-11*).

Keywords: Mitral stenosis ∎ Balloon mitral valvuloplasty ∎ Transvalvular gradient ∎ Pulmonary artery pressure

Introduction

n patients with mild mitral stenosis (MS), the blood flows from the left atrium to the left ventricle only if propelled by a small, although abnormal, pressure gradient.

When the mitral valve area is reduced to 1 cm^2, which is considered to represent critical MS [1], a left atrioventricular pressure gradient of approximately 20 mm Hg is required to maintain the normal cardiac output at rest. The elevated left atrial pressure, in turn, raises pulmonary venous and capillary pressures, resulting in exertional dyspnea [2]. To assess the severity of the obstruction of the mitral valve, both the transvalvular pressure gradient and the transvalvular flow rate must be measured [3].

Pulmonary hypertension in patients with MS results from (1) passive backward transmission of the elevated left atrial pressure; (2) pulmonary arteriolar constriction, which presumably is triggered by left atrial and pulmonary venous hypertension (reactive pulmonary hypertension); and (3) organic obliterative changes in the pulmonary vascular bed, which may be considered to be a complication of longstanding and severe MS [2], [4].

Echocardiography is now the cornerstone of the diagnostic assessment of patients with MS. Also Doppler echocardiography is the most accurate non-invasive technique available for quantifying the severity of MS [5]. The pulmonary arterial pressure also can be estimated from the TR velocity signal [6], [7].

Method

The study population consisted of 49 patients (47 women, 2 men; mean age = 43.7±13.35 years) with symptomatic rheumatic mitral stenosis who underwent balloon mitral valvuloplasty (BMV).

Echocardiographic Studies

Transthoracic echocardiography (TTE) was done the day before BMV and 24–48 hours after (before discharge), using real-time ultrasound imaging system (GE Medical Systems, Vivid 3) with a phased array 2.5-MHz transducer.

The standard echocardiographic measurements were done and averaged in 4 cardiac cycles. These measurements were taken while the patient was on supine and left lateral decubitus positions.

The optimal immediate outcome of BMV was defined as a valve area increment of 50% or more or a final mitral valve area of ≥1.5 cm^2 and mitral regurgitation Sellers' grade ≤ 2. These patients were categorized as group 1.The suboptimal immediate outcome of BMV was defined as a valve area increment <50% or a final valve area of <1.5 cm^2 with mitral regurgitation Sellers' grade ≤ 2, or "severe regurgitation" irrespective of the post-procedural area. These patients were categorized as group 2. Significant post-BMV mitral regurgitation was defined as an increase of two or more grades of angiographic regurgitation after the procedure or a final regurgitation grade ≥3.

Valvuloplasty Procedure

After diagnostic left and right heart catheterization, trans-septal puncture for the Inoue balloon was done. BMV was performed using an appropriate size Inoue balloon catheter (Toray Industries, Japan.) The balloon size was selected according to the body surface area and modified by valve motion on echocardiography [8] and reached after several stepwise inflations. After each

7

dilation, the left atrial and left ventricular pressures were determined to assess the transmitral valve gradient before proceeding to the next dilation. Left ventriculography was performed before and after the last balloon inflation.

Statistical Analysis

The data are described as mean ± standard deviation (SD) for the interval and count (percent) for the categorical variables. The independent sample *t*-test (or its non-parametric equivalent, Mann-Whitney U test) and the one-way analysis of variance (ANOVA) were used to compare the mean of the interval data between the groups. Bonferroni correction was employed for post-hoc comparisons. Simple linear regression models were fitted to investigate the associations between the interval variables.

The statistical analyses were conducted using SPSS 13 for Windows (SPSS INC. Chicago, Illinois).

The study was approved by our faculty Ethics Committee, and written informed consent to the procedure was obtained from all the patients.

Results

After BMV, the mean increase in the mitral valve area was 0.5 ± 0.13 cm^2 in group 1 and 0.28 ± 0.12 cm^2 in group 2 (p value < 0.001). In group 1, the percentage of the decrease in the mitral valve peak pressure gradient (MV PPG) was 47.12% (from 21.6 ± 9.76 mm Hg to 11.42 ± 3.66 mm Hg), in the mitral valve mean pressure gradient (MVMPG) was 56.08% (from 14.3 ± 7.32 mm Hg to 6.28 ± 2.39 mm Hg), and in the peak pulmonary artery pressure (PPAP) was 30.44% (from 56.75 ± 16.86 mm Hg to 39.47 ± 9.35 mm Hg). In group 2, the percentage of the decrease in the MVPPG was 9.42% (from 14.53 ± 6.94 mm Hg to 13.16 ± 8.08 mm Hg), in the MVMPG was 13.45% (from 8.55 ± 5.22 mm Hg to 7.4 ± 7.02 mm Hg), and in the PPAP was 16.65% (from 45.34 ± 9.89 mm Hg to 37.79 ± 14.17 mm Hg).

The measurement data for the two groups are depicted in Table 1.

Table 1: Amount of reduction in MV PPG, MV MPG and PPAP in the two groups after BMV

	Success	N	Mean (mmHg)	Std. Deviation	P value
MVPPG change	no success	27	1.77	3.52	<0.001
	successful	22	10.26	10.16	
MVMPG change	no success	27	1.27	2.6	<0.001
	successful	22	7.36	7.39	
PPAP change	no success	27	6.25	10.26	<0.001
	successful	22	19.21	15	

Discussion

Patients with MS who are asymptomatic or minimally symptomatic frequently remain so for years. However, once moderate symptoms develop (NYHA Class II), if the stenosis is not relieved mechanically, the disease may progress relatively rapidly. BMV or surgical valvotomy should, therefore, be carried out in symptomatic patients with moderate to severe MS (mitral valve orifice area ≤ 1.0 cm^2/m^2 body surface area or
< 1.5 to 1.7 cm^2 in normal-sized adults). BMV or surgical valvotomy should also be carried out in patients with mild stenosis (orifice area $=1.0$ to 1.5 cm^2/m^2 BSA) who are symptomatic during ordinary activity and who develop pulmonary arterial systolic pressures exceeding 60 mm Hg or mean pulmonary capillary wedge pressures exceeding 25 mm Hg during exercise [9], [10].

Commissural separation and fracture of nodular calcium appear to be the mechanisms responsible for improvement in the valvular function.

In several series, the hemodynamic results of BMV have been quite favorable, with reduction of the transmitral pressure gradient from an average of approximately 18 to 6 mm Hg, a small (average 20%) increase in the cardiac output, and an average doubling of the calculated mitral valve area from 1.0 to 2.0 cm^2 [11], [12], [13], [14].
Elevated pulmonary vascular resistance declines rapidly, although usually not completely.

Fawzy and coworkers [15] showed that the pulmonary artery pressure decreased without normalizing immediately after BMV and normalized in patients with optimal results from BMV 7 to 14 months later. Insignificant change in pulmonary vascular resistance was seen immediately after BMV and markedly decreased or normalized at late follow-up in patients with optimal results from BMV. Umesan and colleagues [16], who compared immediate and long-term efficacy of BMV in patients with MS and severe PAH to those with mild to moderate PAH, reported a larger decrease, in the pulmonary artery mean pressure, transmitral gradient, and mean pulmonary artery wedge pressure in group 1 than those in group 2, with a comparable increase in the mitral valve area (1.77 +/- 0.4 and 1.84 +/- 0.5 cm^2) after BMV. Our result is consistent with that reported by Umesan insofar as the amount of MVPPG, MVMPG, and PPAP reduction in the patients with severe PAH were more than those of the patients with mild to moderate PAH.

In our study, although there were decreases in the MVPPG, MVMPG, and PPAP in both patient groups with optimal and suboptimal immediate outcomes, the amount of reduction was significantly larger in the first group.

In conclusion, we found a direct relationship between final MVA after BMV and the amount of reduction in the MVPPG, MVMPG, and PPAP.

References

1- Rahimtoola SH, Durairaj A, Mehra A, Nuno I: Current evaluation and management of patients with mitral stenosis. Circulation 2002; 106:1183.

2- Otto CM. Valvular Heart Disease. 2nd ed. Philadelphia: WB Saunders; 2004, pp 252-255.

3- Baim DS, Grossman W. Cardiac Catheterization, Angiography and Interventions. 6th ed. Baltimore: Lippincott, Williams & Wilkins; 2000, pp 735-756.

4- Alpert IS, Dalen IE, Rahimtoola SH. Valvular Heart Disease. 3rd ed. Philadelphia, Lippincott, Williams & Wilkins; 2000, pp 75-83.

5- Welts Fe, Shapiro LM. Mitral Valve Disease. 2nd ed, London, Butterworths; 1996. pp 47-50.

6- Sagie A, Freitas N, Chen MH, Marshall JE, Weyman AE, Levine RA. Echocardiographic assessment of mitral stenosis and its associated valvular lesions in 205 patients and lack of association with mitral valve prolapse. J Am Soc Echocardiogr aphy 1997; l0:141.

7- Faletr F, Pezzano JA, Fuse R. Measurement of mitral valve area in mitral stenosis: Four echocardiographic methods compared with direct measurement of anatomic orifices. J Am Coll Cardiol 1996; 28:1190.

8- Esmaeilzadeh M, Homayounfar S, Maleki M, Parsaee M, Sadeghpour A, Bakhshandeh H. Iranian Heart Journal 2010;

9- Bonow RO, Carabello B, de Leon AC, Edmunds LH Jr, Fedderly BJ, Freed MD, et al: ACC /AHA guidelines 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 (Committee on Management of Patients with Valvular Heart Disease). J Am Coll Cardiol 1998; 32:1486.

10- Iung B, Gohlke-Barwolf C, Tornos P, Tribouilloy C, Hall R, Butchart E, Vahanian A. Recommendations on the management of the asymptomatic patient with valvular heart disease. Eur Heart J 2002; 23:1253.

11- Orrange E, Kawanishi DT, Lopez BM. Actuarial outcome after catheter balloon commissurotomy in patients with mitral stenosis. Circulation 1997; 95:382.

12- Hernandez R, Banuelos C, Alfonso F, Goicolea J, Fernandez-Oritz A, Escaned J, et al. Long-term clinical and echocardiographic follow-up after percutaneous mitral valvuloplasty with the Inoue balloon. Circulation 1999; 99:1580.

13- Iung B, Garbarz E, Michaud P, Helou S, Farah B, Berdah P, et al. Late results of percutaneous mitral commissurotomy in a series of 1024 patients. Analysis of late clinical deterioration. Frequency, anatomic findings, and predictive factors. Circulation 1999; 99:3273.

14- Kang DH, Park SW, Song JK, Kim HS, Hong MK, Kim JJ, et al. Long-term clinical and echocardiographic outcome of percutaneous mitral valvuloplasy. Randomized comparison of Inoue and double balloon techniques, J Am Coll Cardiol 2000; 35:169.

15- Fawzy M, Mimish L, Sivanandam V, Lingamanaicker J, Patel A, Khan B, et al. Immediate and long-term effect of balloon valvotomy on severe pulmonary hypertension in patients with mitral stenosis. Am Heart J 1996; 131:89.

16- Umesan CV, Kapoor A, Sinha N, Kumar AS, Goel PK. Effect of Inoue balloon mitral valvotomy on severe pulmonary arterial hypertension in 315 patients with rheumatic mitral stenosis: immediate and long-term results. J Heart Valve disease 2000 Sep; 9(5):609-15.