Hemodynamic Evaluation of Mitral Stenosis Before and After PTMC Using Stress Echocardiography

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Abstract

Objectives- The aim of this study was to evaluate the success of PTMC hemodynamically. The hemodynamic data have been evaluated by exercise stress echocardiography in patients with mitral stenosis (MS) following PTMC.

Method- We prospectively studied hemodynamic data in 15 consecutive patients with severe MS who were in NYHA FC two or more. The valve score was less than 9. All the patients underwent PTMC. Treadmill exercise stress echocardiography (Bruce protocol) was done before and one month after PTMC with GE Vingmed CFM 800. Mitral valve area by planimetry and the PHT method, mean TMVG, peak TMVG and PAP were measured in all the patients at rest and within 90 seconds after the termination of exercise.

Results- PTMC was successful in 63% of the patients according to an increased mitral valve area (P=0.001), a decreased post-PTMC mean and peak pressure gradients before and after exercise (P=0.008), and increased exercise tolerance (P=0.016). The mean age of the patients with successful PTMC was lower than that of patients with unsuccessful procedures (38.18±8.15 vs. 43.5±3.1). Exercise tolerance was lower in older patients before and also after successful PTMC.

Conclusions- This study shows that the accurate and reliable indicators of successful PTMC in the cardiac catheterization laboratory are an increased mitral valve area as well as a decreased post-procedural mean TMVG. Therefore, planimetry of the mitral valve using transthoracic echocardiography immediately after PTMC is recommended ***(Iranian Heart Journal 2004; 5(4): 19-23).***

Key words: valvular heart disease ■ mitral stenosis ■ percutaneous transvenous mitral commissurotomy

Echocardiography is the gold standard for the evaluation of mitral stenosis, obviating cardiac catheterization. The pressure gradient across the mitral valve can be overestimated with cardiac catheterization when pulmonary capillary wedge pressure is used (instead of left atrial pressure by transseptal catheterization) to measure the transmitral pressure gradient.[1-7] Although improvements in mitral flow characteristics at rest were observed immediately after the procedure,[8,9] this procedure is to be validated by the observation of mitral flow dynamics during exercise because mitral stenosis critically limits the mitral flow during exercise and can provoke hemodynamic deterioration. Although McKay reported considerable improvements of exercise hemodynamics 3 months after PTMC using a catheterization technique,[10] there is no evidence whether or not mitral flow dynamics during exercise are improved soon after PTMC, because repeated catheterization could not be performed in

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this period due to technical limitations.[11] Doppler echocardiography is a non-invasive and reliable method to assess the mitral flow characteristics and can be applied to the exercise test.[12] In patients with moderate to severe MS who are candidates for PTMC, it seems that the post- procedural mean TMVG alone is not a sufficient indicator for successful PTMC. There are a few symptomatic patients after successful PTMC who show no significant increase in the valve area,[1-5,13-15] so evaluating successful PTMC needs confirmation by other indicators besides mean TMVG. Exercise Doppler echocardiography can be applied to outpatients to determine the indications of PTMC and also to patients receiving PTMC to evaluate the extent of decrease in transmitral pressure gradient after the procedure.[6] In this study, we sought to determine the success of PTMC hemodynamically using exercise stress echocardiography.

Method

We studied 15 consecutive patients undergoing PTMC between January and March at our center. We excluded patients with other significant valvular lesions except for tricuspid insufficiency secondary to pulmonary hypertension. Patients with coronary artery disease were also excluded. We prospectively collected the following data for each patient: age, gender, mitral valve area, mean and peak TMVG (rest and post-exercise), pulmonary artery pressure (rest and post-exercise) and exercise time.

2D transthoracic and Doppler echocardiograms (GE Vingmed CFM 800) were performed in all the patients. We measured mitral valve area by planimetry and PHT method, mean and peak TMVG, and pulmonary artery pressure by TR flow in three consecutive beats and averaged them for analysis. Exercise test was done on a treadmill (Bruce protocol). The end point criteria were the occurrence of symptoms such as dyspnea and or fatigue and also the other end point criteria of the exercise test. Immediately after exercise termination (90 seconds), mean and peak TMVG and pulmonary artery pressures were measured and recorded.

All the patients underwent PTMC by Inoue balloon catheter method.

One month after PTMC, all the patients underwent repeat stress echocardiography.

Data analysis

Continuous data are presented as the mean and standard deviation, and dichotomous data are presented as percentage. We used t test and McNemar testing to determine the association of specific clinical characteristics. Data were analyzed using SPSS 10 software. A P value less than 0.05 was accepted as statistically significant.

Results

There were 11 females (73.36%) with a mean age of 36.6±7.44 years. The majority of the patients were in pre-PTMC NYHA FC II and III. Although there was no significant correlation between the mitral valve area and the mean transmitral pressure gradient at rest before or after PTMC, a significant correlation was observed between the extent of an increase in the mitral valve area and a decrease in the mean transmitral pressure gradient at rest after PTMC. Comparison of variables (mean and peak TMVG, PAP and exercise time) pre- and post-PTMC before and after exercise showed that PTMC was not successful in 4 (27%) patients. Although our data in the above patients did not show significant changes after PTMC (unsuccessful PTMC), in the other 11 (63%) patients, these data revealed significant improvement (successful PTMC). The mean age of the patients with successful PTMC was lower than that of the patients with unsuccessful procedures (38.18±8.15 versus 43.5±3.1 years). Exercise time showed significant changes after successful PTMC (P<0.016).

Older patients had lower exercise time before and after successful PTMC. The pulmonary artery pressure showed no significant changes pre- and post-PTMC before and after exercise, which seems to be related to the increase in exercise time after PTMC with a resultant increase in pulmonary hypertension, and thus could not be considered as a marker of unsuccessful PTMC.

Table I. Mean, SD and P value of hemodynamic data of patients with successful versus unsuccessful PTMC

	"Successful PTMC"			"Non-successful PTMC"		
	Mean	SD	P	Mean	SD	PV
Diff-MVA	0.56	0.38	0.025*	0.065	0.075	NS**
Diff-Mean TMVG [1]	3.65	3.52	0.008*	0.07	0.63	NS
Diff-Mean TMVG [2]	8.46	6.7	0.002*	0.22	1.98	NS
Diff-PAP [1]	3.36	9.01	NS	4.25	8.7	NS
Diff-PAP [2]	10.36	15.83	NS	2.5	5	NS
Diff-ET	2.19	1.5	0.016*	1.35	1.44	NS

*Statistically significant, ** Not-significant
[1] Pre and post-PTMC at rest , [2] Pre and post-PTMC post- exercise

Discussion

PTMC by Inoue balloon catheter improves mitral flow dynamics during exercise, and exercise Doppler study is useful for this evaluation.[6]

Doppler echocardiography has been shown to be a reliable, noninvasive technique for investigating the patients with mitral stenosis[17-19] and to be applicable to the exercise test.[12] Furthermore, this technique has several advantageous points as will be described. First, the severity of mitral stenosis is usually determined by mitral valve area, mean transmitral pressure gradient at rest, or both, although the cardiac symptoms are usually evident only during exercise. Because the transmitral pressure gradient partly depends on the transmitral flow volume and ventricular function, patients with low cardiac output show low-pressure gradients at rest. In contrast, the increase in transmitral pressure gradient during exercise indicates the limited transmitral flow volume and can certainly reflect the severity of mitral stenosis for individual patients. The increase in pressure gradient during exercise after PTMC also clarifies whether the acquired valve area is adequate for the transmitral flow volume of the patient.[6]

Simultaneous measurement of cardiac output and the gradients between the left atrium and the left ventricle and calculation of the valve area remain the gold standard for assessing the severity of MS.

Although a satisfactory mean pulmonary artery wedge pressure provides a good estimate of left atrial mean pressure, some damping in waveform and phase shift (0.06-s time delay) occurs in the transmitted wedge pressure when used as an estimate of left atrial mean pressure.[5]

The difference in assessing the mitral valve area in MS can be important when the measured pressure difference is small. After catheter balloon commissurotomy, the mitral valve area increases. There are reductions of LA and PA pressure at rest and on exercise and increase of exercise capacity. The immediate results of catheter balloon commissurotomy are greatly influenced by the characteristics of the valve and its supporting apparatus, which are best determined by 2D TTE and or TEE echocardiography.[5]

In patients undergoing PTMC, although the mean pressure gradient is a useful marker for successful PTMC, it is not very accurate and reliable because it is flow dependent and can be affected by fasting before the procedure with subsequent decreased preload. This may result in an underestimation of the pressure gradient. Thus, planimetry of the mitral valve is a good indicator of successful PTMC.

Conclusions

This study shows the accurate and reliable indicators of successful PTMC in the cardiac catheterization laboratory are an increased mitral valve area as well as a decreased post-procedural mean TMVG. Therefore, planimetry of the mitral valve using transthoracic echocardiography immediately after PTMC is recommended.

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