Hemodynamic Evaluation of Mitral Stenosis Using Stress Echocardiography

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Abstract

Objectives- The aim of this study was to evaluate the relation of symptoms to valve stenosis. The hemodynamic data were evaluated at rest and after exercise using exercise stress echocardiography.

Methods- We prospectively studied hemodynamic data in 15 consecutive patients with moderate mitral stenosis (MS) who were in NYHA function class two or higher. Treadmill exercise stress echocardiography (Bruce protocol) was done (GE Vingmed CFM 800). Mitral valve area (by planimetry and 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- In 66.7% of patients with moderate mitral stenosis, the stenosis was hemodynamically significant regarding the increase in mean TMVG (2 times in comparison with rest, or more than 15mmHg) and PAP after exercise.

Conclusions- Our results suggest that in patients with moderate mitral stenosis, hemodynamic response to exercise has better correlation with the degree of valve stenosis severity and the occurrence of symptoms. In these patients, exercise stress Doppler echocardiography is a noninvasive and reliable method to assess the mitral flow characteristics ***(Iranian Heart Journal 2007; 8 (2): 35-38).***

Key words: mitral stenosis■ stress echocardiography■ exercise

Echocardiography is the gold standard for the evaluation of mitral stenosis.[1] Doppler echocardiography is the most accurate noninvasive technique available for quantifying the severity of MS,[2] and for estimating pulmonary arterial pressure.[3,4] In addition to determining the anatomical extent and severity of the stenotic lesion, assessment of physiological significance is made using Doppler echocardiography. Both continuous-wave and pulsed-wave Doppler echocardiography can provide accurate quantification of the transvalvar gradients.[5-7] Mitral stenosis critically limits the mitral flow during exercise and can provoke hemodynamic deterioration.[8] Determination of the transvalvular gradient should be performed in patients both at rest and with modest degrees of exercise. A population of symptomatic patients exists who have relatively unimpressive gradients at rest that increase dramatically with mild exercise. The most common significant sequela of mitral stenosis is the development of secondary pulmonary hypertension which also increases dramatically with exercise.

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Doppler echocardiography is a noninvasive and reliable method to assess the mitral flow characteristics and can be applied to the exercise test to assess exercise hemodynamics.[9] Exercise Doppler testing is helpful in the following situations: 1) to confirm that the asymptomatic patient has satisfactory effort tolerance and has no symptoms during workloads equivalent to activities of normal living, 2) to assess pulmonary artery systolic pressure during exercise, and 3) to evaluate exercise hemodynamics in symptomatic patients who appear to have only mild to moderate MS on resting measurements.[10] Exercise Doppler echocardiography can be applied to the symptomatic patients with mild to moderate MS to determine the hemodynamic significance of mitral stenosis.[8] The results of one study revealed that symptoms correlated best with the degree of pulmonary hypertension.[11] In this setting, patients may be treated with a beta-blocker to decrease heart-rate response to exercise or with mitral valvotomy.[12]

Methods

We prospectively studied 15 consecutive patients with moderate mitral stenosis during a period of 6 months at our institution. We excluded patients with other significant valvular lesions (MR, AI) except for tricuspid insufficiency secondary to pulmonary hypertension. Patients with coronary artery disease also were excluded.

2D transthoracic and Doppler echocardiograms (GE Vingmed CFM 800) were performed. In all the patients, mitral valve area (by planimetry and PHT method), mean and peak TMVG and pulmonary artery pressure (by TR flow) were measured in three consecutive beats and averaged for analysis. Exercise test was done by treadmill (Bruce Protocol).

The end point criteria were the occurrence of symptoms (dyspnea or fatigue) and also the other end point criteria of exercise test. Immediately after exercise termination (90 seconds), mean and peak TMVG and pulmonary artery pressure were measured and recorded. We collected prospectively the following data for each patient: age, gender, associated valvular lesions, mitral valve area, mean and peak TMVG (rest and post-exercise) pulmonary artery pressure (rest and post-exercise), and exercise time.

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 between specific clinical characteristics.

Data were analyzed using SPSS 10 software. All statistical tests were considered significant at $P<0.05$.

Results

There were 13 females (86.6%) at a mean age of 42.27±3.05 years. The majority of the patients were in NYHA functional class II.

Mitral valve area was between 1.2-1.7 cm^2 (mean: 1.5±0.23 cm^2). The resting mean TMVG was between 2.25 and 7.50 mmHg (mean: 5.35±2.67 mmHg), which reached between 5.25 and 19.30 mmHg (mean: 14.59±7.9 mmHg) after exercise (P=0.0001).

The resting pulmonary artery pressure was between 25 and 40 mmHg (mean: 30.07±11.85 mmHg), which reached between 35 and 80 mmHg (mean: 49.87±18.67 mmHg) post exercise, P=0.0001 (Table I).

In 66.7% of patients, mean TMVG after exercise was doubled in comparison with rest or was more than 15 mmHg.

Table I. Mean TMVG and PAP before and after exercise in patients with moderate MS.

	Rest	Post-exercise	PV
Mean TMVG	5.35+-2.67	14.59+-7.9	0.0001
PAP	30.07+-11.58	49.87+-18.67	0.0001

Discussion

The clinical decision on interventional therapy for the relief of mitral stenosis must take into consideration the patient's symptoms in addition to the severity of the stenosis based on area and gradient.[13] All hemodynamic data are flow dependent. Heart rate also affects the diastolic filling time and pressure gradients. In patients undergoing medical treatment with diuretics, beta-blockers and/or digoxin, all the above data might be underestimated in resting echocardiography. In some patients, symptoms of mitral stenosis caused by the elevated left atrial pressure and pulmonary congestion may be present only during exercise. Exercise hemodynamics have been used in patients with mitral stenosis to determine whether the mitral stenosis limits the transmitral flow and contributes to the patients' symptoms.[14] Doppler echocardiography has been shown to be a reliable, noninvasive technique for investigating the patients with mitral stenosis[15-17] and to be applicable to the exercise test.[18] Furthermore, this technique has several advantageous points. First, 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 also clarifies whether the valve area is adequate for the transmitral flow volume of the patient.[8]

Stress testing in patients with mitral stenosis is performed during supine bicycle or pharmacologic stress,[8] but in this study we used treadmill exercise stress echocardiography because it is not only popular but it is also associated with a higher maximal heart rate and cardiac workloads. In our study, in line with a previous study by Song et al., the occurrence of symptoms and functional capacity were strongly dependent on pulmonary artery pressure at peak exercise.

Therefore, the evaluation of hemodynamic data after exercise should be considered in symptomatic patients with moderate mitral stenosis. Exercise stress Doppler echocardiography is a good tool for the evaluation of functional class and also the relation between symptoms and valve stenosis.

Conclusions

When there is a discrepancy between the severity of valve stenosis and the clinical symptoms, an evaluation of valvular hemodynamics with exercise is helpful. Measurement of the mitral pressure gradient and pulmonary pressure with exercise can often be diagnostic. With increased heart rate, the mitral pressure gradient and pulmonary pressure increase, which can explain the symptoms. In these patients, hemodynamic response to exercise has better correlation with the degree of valve stenosis severity and the occurrence of symptoms. As a result, in

symptomatic patients with moderate MS exercise Doppler stress echocardiography is recommended.

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