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Hemodynamic Evaluation of Mitral Stenosis Using Stress Echocardiography

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Abstract: The aim of this study is to evaluate the relation of symptoms to valve stenosis. The hemodynamic data have been evaluated at rest and after exercise using exercise stress echocardiography. We prospectively studied hemodynamic data in 15 consecutive patients with moderate MS who were in NYHA FC two or more. 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 sec, after the termination of exercise. In 66.7% patients with moderate mitral stenosis the stenosis was hemodynamically significant regarding to increase in mean TMVG (2 times in comparison with rest or more than 15 mmHg) and PAP after exercise. 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.

Key words: Hemodynamic, Value stenosis, echocardiography,

INTRODUCTION

Echocardiography is the gold standard for 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 transvalvular 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 degree 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 sequelae of mitral stenosis is development of secondary pulmonary hypertension which also increased dramatically with exercise. 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 b-blocker to decrease heart-rate response to exercise or with mitral valvotomy[12].

METRIALS AND METHODS

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

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Table 1: Mean TMVG and PAP before and after exercise in patients with Moderate MS

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

(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 sec) mean and peak TMVG and pulmonary artery pressure were measured and recorded. We collected prospectively the following data for each patients: 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 Mc Nemar testing to determine the association of specific clinical characteristics.

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

RESULTS

There were 13 females (86.6%) with 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 cm2 (mean: 1.5 + -0.23 cm2).The resting mean TMVG was between 2.25-7.50 mmHg (mean: 5.35 + -2.67 mmHg) which reaches after exercise between 5.25-19.30 mmHg (mean: 14.59 + -7.9 mmHg), p= 0.0001

The resting pulmonary artery pressure was between 25-40 mmHg (mean: 30.07 + -11.85 mmHg) which reaches post exercise between 35-80 mmHg (mean: 49.87 + -18.67 mmHg), p = 0.0001(Table 1).

In 66.7% of patients mean TMVG after exercise was increased 2 times in comparison with rest or was more than 15 mmHg.

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 who are undergoing medical treatment with diuretics, Beta-Blockers and or digoxin all 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 has been used in patients with mitral stenosis to determine whether the mitral stenosis limits the transmitral flow and contributes to the patient's 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 as will be described. 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 gradient 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 patient. 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 also is associated with a higher maximal heart rate and cardiac workloads. In our study such as the 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 evaluation of functional class and also the relation between symptoms and valve stenosis.

CONCLUSION

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 often can 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. Therefore in symptomatic patients with moderate MS exercise Doppler stress echocardiography is recommended.

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