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RESEARCH ARTICLE

RIGHT VENTRICULAR SYSTOLIC FUNCTION IN PATIENTS WITH RHEUMATIC MITRAL STENOSIS

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ABSTRACT

Background: Right ventricle(RV) function affects the outcome in valvular heart disease but it less assessed in mitral stenosis.

Our study aims to define the incidence of RV dysfunction in patients with moderate to severe rheumatic mitral stenosis using simple parameters and to correlate it with other echocardiographic parameters.

Methods: 75 patients with moderate to severe rheumatic mitral stenosis and 24 controls underwent echocardiographic examinations.

RV function indices included Tricuspid annular plane excursion (TAPSE), peak S' velocity at tissue Doppler (S') and RV fractional area shortening (FAS).

Results: compared to controls, patients with MS had significantly lower TAPSE (17±5 vs 20mm, p<0.001), lower FSA (0.43±0.1 vs 0.52±0.2%, p=0.03) and lower S' (11±3 vs 13±1 cm/s, p=0.002).

Right ventricular dysfunction was noted in 38% (by TAPSE), in 37% (by S') and in 35% (by FSA). A good correlation was noted between these three parameters. RV systolic dysfunction was significantly more frequent in patients with atrial fibrillation (AF) than those in sinus rhythm (60% vs 20%, p<0.001), and left atrial area was significantly higher in patients with right ventricular dysfunction (34.8 cm² vs 31.6 cm², p=0.04). A cut-off value of 34cm² can predict right ventricular dysfunction with 86% sensitivity and 77% specificity. No correlation was found between the three parameters of RV function and systolic pulmonary artery pressure.

Conclusion: systolic RV function, assessed by simple echocardiographic parameters, was reduced in 35% of patients with moderate to severe mitral stenosis. RV dysfunction was more frequent in patients with AF and with more dilated left atrium

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INTRODUCTION

The right ventricular function in valvular heart disease and particularly in mitral stenosis is poorly assessed, whereas it is known that right ventricular dysfunction is associated with poor prognosis (Nagel *et al.*, 1996). RV assessment is difficult because of the crescentic shape, separate infundibulum, prominent trabeculation of the chamber and high load dependence (Silverman *et al.*, 1983). Recently, simple echocardiographic parameters of systolic right ventricular function were validated and normal values were well defined (Rudski *et al.*, 2010). This study was designed to assess, with these simple parameters, the incidence of RV dysfunction in patients with moderate to severe rheumatic mitral stenosis and the correlation between echocardiographic findings and right ventricular dysfunction.

MATERIALS AND METHODS

Population

Between April 2007 and march 2010, patients with predominante mitral stenosis and not more than moderate regurgitation were enrolled. The non inclusion criteria were significant other valvular heart disease, dilated or ischemic cardiomyopathy, acute pulmonary embolism, chronic pulmonary disease and significant left to right shunt. These parameters were also compared with that from twenty four healthy controls, matched by age and gender. None had ECG or echocardiographic evidence of cardiovascular disease.

Echocardiographic measurements

Echocardiographic imaging was performed using an aloka system 5000. All measurements were performed by the same

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experienced echocardiographer using the recommendations of the American Society of Echocardiography (Rudski *et al.*, 2010).

Mitral valve area (MVA) was determined by planimetry using parasternal short axis view. An area $<1.5\text{cm}^2$ defined a moderate to severe mitral stenosis. Left atrial area was estimated in 4 chamber apical view at end systole (dilated if $\text{area}>20\text{cm}^2$). Systolic pulmonary artery pressure (SPAP) was derived from the tricuspid regurgitant jet peak velocity using the modified Bernoulli equation (peak gradient $4V^2$, V is the maximal velocity of the tricuspid regurgitant jet). Assessment of right atrial mean pressure was based on the inferior vena cava dilation and respiratory variations. Pulmonary hypertension was defined if SPAP $>35\text{mmHg}$, severe if $>50\text{mmHg}$. Mitral regurgitation was evaluated by PISA method.

RV function was assessed by tricuspid annular plane systolic excursion (TAPSE), fractional shortening area of right ventricle (FSA) and peak systolic velocity at tricuspid annular (S'). All the measurements were performed according to guidelines for assessment of right heart set by American society of echocardiography (ASE) (Rudski *et al.*, 2010) and the values of each parameter were obtained after averaging over three cardiac cycles (five to ten cycles in atrial fibrillation).

TAPSE was estimated using apical four-chamber view; the M mode cursor was placed through the junction of the tricuspid valve plane and RV free wall and the difference in the displacement of RV base during systole and diastole was noted. FSA was obtained by tracing the RV endocardium both in systole and diastole from the annulus, along the free wall to the apex, and then back to the annulus, along the interventricular septum. S' was performed using an apical 4-chamber with a tissue Doppler mode region of interest on the RV free wall. The pulsed Doppler sample volume was placed in the tricuspid annulus of the basal segment of the RV free wall. The following cut-off values were taken as evidence of right ventricular dysfunction based on echocardiographic indices: a TAPSE value of $<1.6\text{ cm}$, a FSA $<35\%$ and an S' value $<10\text{cm/s}$

Statistics

Data were expressed as mean \pm standard deviation (SD). Analysis employed the Student's t-test for paired data. The differences between patients with MS and healthy subjects were identified using an unpaired Student's t-test. To show the relationship between the variables in the patient groups, Pearson correlation analysis was performed. A p-value 0.05 was considered statistically significant. All analysis were performed with SPSS 11.5 version.

RESULTS

Seventy five patients with mitral stenosis were included. The mean age was 42 ± 10 years, and 59 (79%) were female. Thirty patients (40%) with MS were in atrial fibrillation at the time of echocardiographic exam, whereas the remaining 45 (60%)

were in normal sinus rhythm. By planimetry, the mean MVA was $1.1\pm 0.26\text{ cm}^2$, mild mitral regurgitation was noted in 62%. Tricuspid regurgitation was detected in 93% allowing estimation of SPAP in 70 patients. Mean SPAP was $44\pm 17\text{mmHg}$ (severe in 21%). Compared with controls, patients with MS had significantly lower TAPSE (17 ± 5 vs 20mm , $p<0.001$), lower FSA (0.43 ± 0.1 vs $0.52\pm 0.2\%$, $p=0.03$) and lower S' (11 ± 3 vs $13\pm 1\text{ cm/s}$, $p=0.002$). Right ventricular dysfunction was noted in 38% (by TAPSE), in 37% (by S') and in 35% (by FSA). A strong positive correlation was noted between these three parameters (Figures 1, 2, 3).

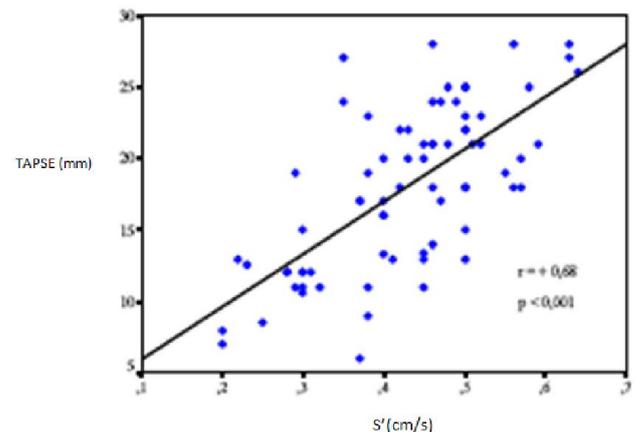


Figure 1. Correlation between TAPSE and S'

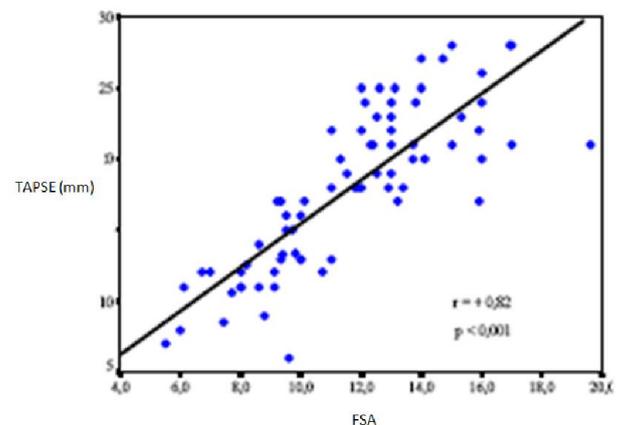


Figure 2. Correlation between TAPSE and FSA'

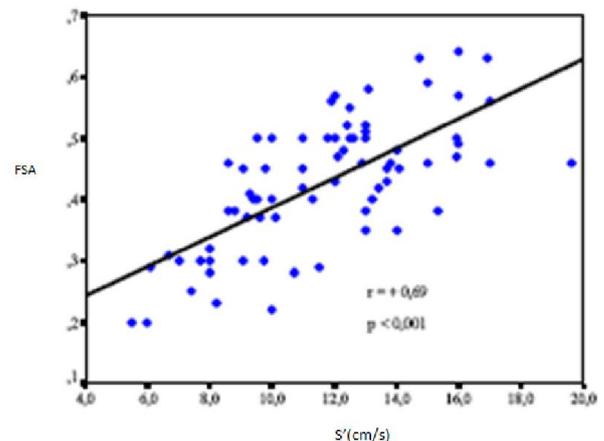


Figure 3. correlation between FSA and S'

Mitral stenosis severity was not correlated with systolic right ventricular function when we divided the population in two groups (moderate stenosis and severe stenosis) ($p=0.8$ for FSA, $p=0.28$ for S' and $p=0.11$ for TAPSE). Otherwise, a correlation was found between tricuspid regurgitation severity (grade 2 vs grade 0 or 1) and TAPSE ($p=0.001$) and S' ($p=0.001$). Right ventricular systolic dysfunction was significantly more frequent in patients with atrial fibrillation than those in sinus rhythm (60% vs 20%, $p<0.001$), and in the same way left atrial area was significantly higher in patients with right ventricular dysfunction (34.8 cm² vs 31.6 cm², $p=0.04$). A cut-off value of 34cm² can predict right ventricular dysfunction with 86% sensitivity and 77% specificity. We don't found correlation between the three parameters of right ventricular function and systolic pulmonary artery pressure. This result persist even if we separated the population in two groups (group I: $35 \leq \text{SPAP} \leq 50$ mmHg and group II: $\text{SPAP} \geq 50$ mmHg).

DISCUSSION

This study evaluated right systolic ventricular function in patients with moderate to severe rheumatic mitral stenosis disease using three parameters (TAPSE, FSA and S'). Our results suggest that patients with moderate to severe MS have depressed RV function compared with normal subjects, findings in accordance with previous radionuclide (Cohen *et al.*, 1985) and hemodynamic studies (Iskandrian *et al.*, 1984). The incidence of right ventricular dysfunction was about 35% in these patients with a good correlation between the three parameters TAPSE, FSA and S' . An advantage of our study was the use of cut-offs defined by recent guidelines on the right ventricular function (Rudski *et al.*, 2010). Right systolic ventricular function was correlated with left atrial area and with tricuspid regurgitation.

Effectively, the cause of RV dysfunction in mitral stenosis, is usually attributed to the increased RV afterload by left atrial hypertension leading to chronic pulmonary venous congestion. This explains well the correlation between right ventricular function and left atrial area and tricuspid regurgitation. However, there is a controversé about the reasons for impairment of right ventricular function in pure MS. It was suggested that depressed right myocardial function can be the consequence of the direct rheumatic involvement of the RV with resultant myocyte necrosis, replacement fibrosis and calcification. An histo-morphological study of cases of rheumatic heart disease, found that intramyocardial branches of coronary vessels were involved in a form of active rheumatic vasculitis or inactive lesions with medial hypertrophy and replacement fibrosis which can affect myocardial function (Malhotra *et al.*, 1987). These hypothesis can explain why we don't found correlation between parameters of right ventricular function and pulmonary hypertension in our study and in other studies (Sadeghpour *et al.*, 2008 and Ragab *et al.*, 2011).

In Pande's study (Pande *et al.*, 2009) including 70 patients with predominant mitral stenosis, patients with no or mild pulmonary hypertension had a right ventricular dysfunction. Previous studies have shown that RV dysfunction, using TAPSE, is a better predictor of outcome than pulmonary

hypertension in patients with primary pulmonary hypertension (Forfia *et al.*, 2006). This question can be proposed for patients with mitral stenosis; can right ventricular dysfunction predict better the outcome of these patients than pulmonary artery pressure which is charge-dependant and if this parameter must be included in decision criteria?

Study limitations

The small number of patients was the main limitation of our study. This was due to the non inclusion criteria, which aimed to limit the confounding factors interfering with right ventricular function. Regurgitant tricuspid flow was used for assessing pulmonary pressure but it isn't a perfect method. In fact, the correlation between pulmonary pressure assessed by right heart catheterization and Doppler methods in pulmonary hypertension is low. This may explain, in part, the no relationship between RV function and pulmonary pressure.

Conclusion

Systolic right ventricular function, assessed by simple echocardiographic parameters, is reduced in 35% of patients with moderate to severe stenosis. Right ventricular dysfunction is more frequent in patients with atrial fibrillation, with more dilated left atrium but no correlation exists between the right ventricular dysfunction and systolic pulmonary artery pressure. No conflicts of interest

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