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ORIGINAL ARTICLE

Worsening of left ventricular twist mechanics in isolated rheumatic mitral stenosis immediately after balloon mitral valvuloplasty



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KEYWORDS

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Abstract *Background:* Reportedly, left ventricular (LV) mechanics are worsened in patients with mitral stenosis (MS) compared to controls. The immediate effect of balloon mitral valvuloplasty (BMV) on LV mechanics is, however, not known.

Aim: To assess the immediate effect of balloon mitral valvuloplasty on the left ventricular twist mechanics.

Methods and results: We studied 39 candidates for BMV. Pressures were measured invasively before and after BMV. Speckle tracking echocardiography (STE) was done for twist mechanics (basal rotation, apical rotation, and torsion) before and immediately after BMV. Twist mechanics were also measured by STE in 15 normal subjects as control group. Mean age was 30.4 ± 7.2 years, mean BMI was 24.7 ± 3.1 and 28 patients (72%) were females. All twist mechanics apical rotation and torsion were lower post-BMV compared to pre-BMV. Left ventricular end diastolic pressure was significantly higher post compared to pre-BMV while left atrial pressure (LAP) was similar between both groups. Importantly, patients who showed an increased LVEDP post compared to pre-BMV had worse LV twist mechanics than those whose LVEDP post-BMV was similar to or lower than pre-BMV.

Conclusion: LV twist mechanics are worsened in MS with a further worsening, immediately after BMV probably because of failure of the LV to adapt to the sudden increased preload.

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1. Introduction

Mitral stenosis (MS) is the most common valve lesion seen in chronic rheumatic heart disease, and results from the inflammatory.¹ As a result of the decreased valve area, LV preload decreased significantly and thus LV systolic performance

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in patients with MS is controversial.^{2–5} Reportedly, LV systolic dysfunction occurs in patients with rheumatic MS, probably because reduced preload in these patients results in adverse LV remodeling, or due to the extension of inflammatory process from the mitral valve apparatus into the adjacent myocardium.^{3–5}

LV systolic dysfunction in MS is difficult to be appreciated using the conventional methods such as LV ejection fraction (LV-EF), which decreases only with significant myocardial damage. With the recent introduction of speckle tracking echocardiography technique (STE), the appreciation of LV systolic dysfunction before they manifest as a decrease in LV-EF became possible.^{6,7}

Mechanically, the myocardial fibers deform in the form of longitudinal and circumferential shortening and radial thickening, in addition to the opposite rotations of the LV apex and base that result in a wringing motion, i.e. LV twist or torsion.⁸ All deformational behaviors of the myocardium can be appreciated by STE. LV torsion is of particular importance for systolic ejection and recoil of torsional forces (untwist) creates negative suction pressures and thus is important for diastolic filling.⁹ LV torsion is load dependent and, with constant afterload, LV torsion increases with increasing preload and vice versa.⁹

Despite that some reports suggested that STE derived LV mechanics are worsened in MS compared to controls,^{3,10,11} little is known about the immediate effect of balloon mitral valvuloplasty (BMV) in patients with MS on the systolic performance of the LV.

As would be expected from the volume dependency of LV twist mechanics in a normal LV, torsion should increase immediately after BMV, because BMV increases LV preload back to relatively normal values; however, this concept is not yet studied.

Therefore, the aim of the present study was to assess the immediate effect of balloon mitral valvuloplasty on the left ventricular twist mechanics.

2. Patients and methods

2.1. Study population

In the period between August 2013 and June 2014, 39 consecutive patients with rheumatic MS referred to our echocardiography laboratory for pre-balloon mitral valvuloplasty (BMV) assessment, were recruited. In addition, 15 age, sex, and LV function matched controls were also recruited. The study protocol was approved by the research committee of our institution, and all patients gave informed consent consistent with this protocol.

2.2. Echocardiography

Echocardiographic examinations were done within 1 h before and within 6 h after BMV. All echocardiographic studies were acquired with a commercially available echocardiography system using a 2.5 MHz multi-frequency phased array transducer (Vivid 5 or 7; GE Vingmed Ultrasound AS, Horten, Norway). The LV-EF was assessed using the biplane Simpson's method by manual tracing of the digital images. The mean trans-valvular pressure gradient (PG) was calculated by manual tracing of the Doppler derived transmitral flow envelope.

From the parasternal LV short-axis view at the mitral valve level, the smallest orifice of the mitral valve was identified by scanning from the left atrium in the direction of the LV apex. The gain settings were adjusted until the lowest level was determined, at which the circumference of the mitral orifice was still visible. After identification of the frame with the mitral valve orifice at its maximal opening in early diastole, MVA was measured by planimetry of its contours. The anatomic severity of MS was defined as mild if MVA was $> 1.5 \text{ cm}^2$, moderate if MVA was > 1.0 and $\leq 1.5 \text{ cm}^2$, and severe if MVA was $\leq 1.0 \text{ cm}^2$.¹²

BMV procedural success was defined as post-procedural MVA $> 1.5 \text{ cm}^2$ with $\geq 25\%$ gain in mitral valve area and mitral regurgitation ≤ 2 .¹³

2.3. Speckle tracking echocardiography (STE)

Short-axis images at the mitral valve and apical level were obtained with a frame rate > 50 frames/s. The LV endocardial border was manually traced at the LV basal and apical levels and the speckle-tracking region of interest was automatically selected, the width of which was adjusted as necessary to accommodate the thickness of the LV wall. Stable objects were automatically tracked in each frame throughout the cardiac cycle and LV basal and apical rotation curves were generated, as previously described.¹⁴

LV torsion was defined as the difference between the peak rotations at the apical and mitral valve level (torsion = peak apical rotation – peak basal rotation).¹⁴

2.4. Statistical analysis

Nominal data were expressed as number (%). Continuous data were expressed as mean $\pm$ SD and were compared between groups using Student *t*-test. Correlation analyses were performed using linear regression and expressed as Pearson correlation coefficients. *p*-value ≤ 0.05 was considered statistically significant. All the analyses were performed with commercially available software (SPSS version 21.0, SPSS, Inc., Chicago, IL, USA). The authors had full access to the data and take full responsibility for their integrity.

3. Results

The study included 39 patients with mitral stenosis, all were in sinus rhythm and were candidates for balloon mitral valvuloplasty (BMV). The mean age was 30.4 ± 7.2 years, mean BMI was 24.7 ± 3.1 and 28 patients (72%) were females. Basic demographic, clinical and echocardiographic data of the study group are listed in Table 1.

3.1. Comparisons between patients and controls

In our study, 15 control subjects were studied. The mean age of controls was 32.7 ± 5.1 years, 8 (60%) were females, and the mean left ventricular ejection fraction was $64.6 \pm 6\%$. There was no significant difference between patients and controls regarding age ($p = 0.261$), sex ($p = 0.646$), and basal left ventricular ejection fraction ($p = 0.121$).

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