The Egyptian Heart Journal (2015) 67, 193–198

HOSTED BY

Egyptian Society of Cardiology

The Egyptian Heart Journal

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ORIGINAL ARTICLE

Role of two dimensional strain and strain rate imaging in assessment of left ventricular systolic function in patients with rheumatic mitral stenosis and normal ejection fraction

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Received 5 November 2013; accepted 19 July 2014
Available online 13 August 2014

KEYWORDS

Strain;
Strain rate;
LV;
Systolic function;
Mitral stenosis

Abstract *Introduction:* Conventional echocardiographic parameters are not able to detect subclinical left ventricular (LV) systolic dysfunction in patients with mitral stenosis (MS). Two-dimensional (2D) longitudinal strain (S) and strain rate (Sr) imaging is a new technique which evaluates global LV systolic function with high reproducibility. The aim of the study was to assess LV systolic function, in patients with moderate–severe MS and normal ejection fraction (EF%), by 2D longitudinal systolic S and Sr imaging.

Patients and method: The study included 50 patients with an established diagnosis of MS (mean age: 32 ± 8 years) and 30 age-matched healthy individuals (mean age 34 ± 7 years). The mitral valve area (MVA) was measured by planimetry and pressure half time (PHT) methods. 2D longitudinal systolic S and Sr imaging was performed for each participant from the apical long axis (LAX), 4 chamber (4C) and 2 chamber (2C) views. Global longitudinal systolic S and Sr were calculated by averaging the three apical views.

Results: There were no significant differences in LV EF%, LV end-systolic and end-diastolic dimensions between the two groups. Patients with MS had significantly lower 2D longitudinal LV systolic S and Sr compared to the control group (<0.001 and <0.05 respectively).

Conclusion: Patients with MS and preserved EF% had lower 2D longitudinal LV systolic S and Sr compared to the control group. 2D longitudinal LV systolic S and Sr imaging appears to be useful in the detection of subclinical LV systolic dysfunction in patients with MS and preserved EF%.

1. Introduction

The most common pathophysiologic cause of mitral stenosis (MS) is rheumatic disease.[1] Generally; LV systolic function in isolated MS is well preserved.[2] In some patients with MS,

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Peer review under responsibility of Egyptian Society of Cardiology.

http://dx.doi.org/10.1016/j.ehj.2014.07.003

pathological alterations might occur in the LV muscle cells and impair the LV contractile function.[3] The presence of impaired LV systolic function, determined by M-mode and/or two-dimensional echocardiography was noted only in 25–30% of patients with MS.[4]

Conventional echocardiographic parameters are not able to demonstrate subclinical LV dysfunction in patients with MS.[1] Recently, two-dimensional (2D) strain and strain rate imaging is used for the quantitative assessment of global and segmental LV function from 2D images.[2]

Strain (S) defines the myocardial deformation, and strain rate (Sr) defines the rate of deformation. S and Sr can be obtained either as tissue Doppler imaging (TDI) or 2D speckle tracking–derived parameters. 2D speckle tracking imaging of the S and Sr overcomes the major limitations of the TDI (tethering and the rotation motion of the heart).[5]

1.1. Aim of the study

To assess LV systolic function, in patients with moderate–severe MS and normal EF%, by 2D longitudinal systolic S and Sr imaging

2. Patients and methods

The study subjects consisted of 50 patients with established diagnosis of MS (40 women and 10 men, mean age: 32 ± 8 years) and 30 age-matched healthy individuals (24 women and 6 men, mean age: 34 ± 7 years). The study was approved by the ethics committee of the hospital and all included subjects have consented to be enrolled in this study.

2.1. Exclusion criteria

Patients with coronary artery disease (CAD) and apparent LV wall motion abnormalities.

1. Patients with LV systolic dysfunction (EF% < 50%).
2. Patients with cardiac rhythm or conduction disturbances such as atrial fibrillation or artificial pacing.
3. Patients with concomitant moderate or severe mitral regurgitation, aortic stenosis and aortic regurgitation.

Each person included in the study was subjected to:

1. Careful history taking and thorough physical examination
2. *Standard twelve-lead electrocardiogram:* For assessment of cardiac rhythm and features suggesting chamber enlargement and CAD.
3. *Basic echocardiographic measurements:* Echocardiography was performed using an Aplio 400, Toshiba, Japan ultrasonographic machine with an M4S transducer. Patients were monitored through a single-lead electrocardiogram. The left atrial diameter, left ventricular end-systolic and end-diastolic diameters, left ventricular fractional shortening percentage, the thickness of the interventricular septum (IVS), and the posterior wall (PW) were measured according to the recommendations of the American Society of Echocardiography.[6] The LV ejection fraction was calculated by Simpson's biplane method of disks. Conventional MS indices, such as maximum mitral valve pressure gradient (PG) and mean mitral valve pressure gradient (MG) were calculated. Mitral valve area (MVA) was measured by mitral orifice planimetry in parasternal short axis view, and by the Doppler derived pressure halftime method (PHT) and the average area was calculated by the mean value of two measurements. MS severity was calculated based on hemodynamic data, using MVA, MG and pulmonary artery systolic pressure (PAP) as follows: mild MS (MVA > 1.5 cm^2, MG < 5 mmHg, or PAP < 30 mmHg), moderate MS (MVA 1.0–1.5 cm^2, MG 5–10 mmHg, or PAP 30–50 mmHg), and severe MS (MVA < 1.0 cm^2, MG > 10 mmHg, or PAP > 50 mmHg). PAP was measured by adding 10 mmHg, considering the diameter of the inferior vena cava and level of its collapse resulting from respiration, to the value measured by evaluating the Bernoulli equation, which is simplified from tricuspid insufficiency velocities. The valvular insufficiency was evaluated by color flow Doppler imaging.
4. *Measurement of the 2D strain and strain rate:* 2D echocardiography images (transmit/receive 1.9/4.0 MHz) were obtained from LV apical LAX,4C, and 2C views with frame rates of 50–90 frames/s. Digital data were stored and analyzed off-line. LV endocardial surface was traced manually, and the speckle tracking width was modified so as to cover the whole LV wall thickness to obtain curves. Peak LV longitudinal systolic strain (LSS) and strain rate (LSSr) were calculated for apical LAX, 4C, and 2C views, and global LV systolic strain (GLSS) and strain rate (GLSSr) were calculated by averaging the three apical views as shown in Figs. 1–3. All the echocardiographic studies were performed by one echocardiographer and for intra-observer variability, a sample of 2D strain and strain rate measurements was randomly selected and examined by the same observer in two different days and intra-class correlation coefficients for the same observer were calculated.

3. Statistical analysis

Collected data were computerized and analyzed using Statistical Package for Social Science (SPSS) version 16. Quantitative variables were expressed as mean ± standard deviation (SD). Student's t-test was used to compare the normally distributed continuous variable between patients with MS and the healthy control group.

4. Results

4.1. Demographic and conventional echocardiographic characteristic

Age and gender indices were similar in the control group and patients with MS ($p > 0.05$), heart rate was significantly higher in patients with MS compared to the control group ($p < 0.05$). There was no significant difference between systolic and diastolic blood pressures in patients with MS compared to the control group ($p > 0.05$). There was no significant difference in IVS and PW thickness, LVESD, LVEDD, LVESV,