Acute Effect of Treatment of Mitral Stenosis on Left Atrium Function

Abstract

Aim: Peak atrial longitudinal strain (PALS) is used to evaluate left atrium (LA) function in patients with mitral stenosis (MS), before and after percutaneous transmitral commissurotomy (PTMC) and mitral valve replacement (MVR). **Methods:** Patients with severe symptomatic MS, who were referred to our echocardiographic laboratory for a diagnostic examination before cardiac surgery or PTMC from October of 2014 to October of 2015, were included in the study. **Result:** The peak systolic global LA strain improved post-PTMC ($P < 0.001$) and post-MVR ($P = 0.012$). This difference was statistically highly significant. **Conclusion:** PALS is impaired in patients with severe symptomatic MS and improved acutely after treatment and may be a good indicator of LA function and may predict the right time for intervention on mitral valve.

Keywords: *Left atrium, mitral stenosis, peak atrial longitudinal strain*

Atooshe Rohani, Shahram Kargar[1], Afsoon Fazlinejad[1], Fereshte Ghaderi[2], Vida Vakili[3], Homa Falsoleiman, Ramin Khamene Bagheri

From the Departments of Cardiology and [3]Social Medicine, Faculty of Medicine, Mashhad University of Medical Sciences, [1]Mashhad Cardiac Research Center, School of Medicine, Mashhad University of Medical Sciences, [2]Atherosclerosis Research Center, School of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

Address for correspondence:
Dr. Shahram Kargar, Quaem Hospital, Mashhad, Iran.
E-mail: atooshe.rohani@gmail.com

Introduction

Mitral stenosis (MS) is the most common valve disease seen as a sequel of rheumatic fever and usually presents with exertional dyspnea and right side heart failure and pulmonary arterial hypertension. Dilation and fibrosis of the left atrium (LA) and disorganization of the atrial muscle bundles occur in patients with MS.[1] During left ventricular (LV) systole, LA acts as a reservoir, LA enlarges lead to LA longitudinal lengthening, and lengthening is recorded as a positive strain, permitting the measurement of longitudinal stretching of LA. The average value of positive peak strain normal values by two-dimensional speckle tracking echocardiograph (2D STE) is 23.2% ± 6.7%.[2] In a review of literature, peak atrial longitudinal strain (PALS) is the predictor of atrial fibrillation (AF) and cardiovascular outcome.[3,4]

Quantification of regional and global LA deformation or LA strain by 2D STE is a diagnostic tool, capable to evaluate LA function and estimation of pulmonary capillary wedge pressure.[5]

In a study conducted on 2012, mitral regurgitation has a negative impact on LA function.[6] There is a study about the impact of MS on LV function evaluated by 2D STE which showed that strain is reduced in patients with severe MS and is related to the hemodynamic severity of MS.[7] The aim of the present study was to assess the LA function and reversibility of its function using PALS with therapeutic interventions in patients with severe MS.

Methods

All patients gave verbal informed consent for the participation to the study, and all work was in compliance with the hospital ethic committee. Patients with severe MS, according to the American Society of Echocardiography (ASE) guidelines, who were referred to our echocardiographic laboratory for a diagnostic examination before cardiac surgery or percutaneous transmitral commissurotomy (PTMC) from October of 2014 to October of 2015, were included in the study. Patients referred for PTMC or mitral valve replacement (MVR) according to the morphological and functional characteristics of valve.

Inclusion criteria were:

- The presence of symptomatic severe rheumatic MS
- Normal LV ejection fraction (EF) (≥55%)
- Normal coronary angiography
- Successful PTMC and normal prosthetic valve function post-MVR
- Right ventricular systolic annular velocity ≥9.5 cm/s before procedure.

How to cite this article: Rohani A, Kargar S, Fazlinejad A, Ghaderi F, Vakili V, Falsoleiman H, *et al.* Acute effect of treatment of mitral stenosis on left atrium function. Ann Card Anaesth 2017;20:42-4.

Received: April, 2016. **Accepted:** November, 2016.

Access this article online

Website: www.annals.in

DOI: 10.4103/0971-9784.197832

Quick Response Code:

Exclusion criteria were:

- Coexistence of aortic valve disease of more than a mild degree
- Low-quality echocardiographic image
- Patients with atrioventricular conduction abnormalities
- LA appendage clot
- More than mild to moderate mitral regurgitation.

For speckle tracking analysis, apical 4- and 2-chamber view images were obtained during breath-hold and with a stable electrocardiographic recording. Care was taken not to foreshorten the LA. Five consecutive heart cycles were recorded and averaged. The frame rate was set at 60–80 frames/s. The analysis of files recorded was performed off-line by two experienced and independent echocardiographer, who was not directly involved in the image acquisition and had no knowledge of the other echocardiographic parameters, using Philips iE33 xMATRIX echocardiography machine. According to the current ASE/European Association of Echocardiography Consensus, the global positive PALS was measured at the end of the reservoir phase using a 12-segment model and QRS onset as the reference point before and after the procedure.

Patients were assessed for pulmonary arterial systolic pressure (PAP); it was estimated from the tricuspid regurgitation always adding 5 mmHg. The maximum LA volume was calculated from apical four- and two-chamber zoomed views of the LA and indexed for body surface area, using the biplane method, mitral valve area (MVA) was evaluated using 2D planimetry, and the pressure half-time method, LVEF, LV dimensions, volumes were made in accordance with current recommendations of ASE.

Reproducibility

Intra- and inter-observer variability for STE were assessed, which were 7% and 9%, respectively.

Statistical analysis

For paired data, Student's *t*-test (independent *t*-test and paired *t*-test) used to determine the significance of differences in parameters pre- and post-PTMC and MVR after testing for normal distribution. Variables were expressed as a mean ± standard deviation. The differences in means of the parameters between patients with severe MS before and after intervention were analyzed using paired Student's *t*-test for normally distributed variables. Pearson's correlation analysis was done to show the relationship between the variables in MS patients. $P \leq 0.05$ was considered statistically significant. Statistical analyses were done using software SPSS version 19 (IBM corporation, USA).

Results

Our study included 46 adult patients (mean age, 46.8 ± 12.5 years), 31 females (67.4%) and 15 males (32.6%), 69.5% of patients had normal sinus rhythm and 14 patients (30.5%) had AF. Twenty-eight patients (60.9%) underwent PTMC and 18 patients (39.1%) had MVR. LVEF was similar in both groups ($P = 0.7$). Nonsignificant correlation was found between MV area and PALS ($r = 0.0293$); however, left atrial longitudinal strain correlated significantly with mean transmitral pressure gradient drop ($r = 0.6$) after PTMC.

The peak systolic global LA strain was much improved post-PTMC ($P < 0.001$) and post-MVR ($P = 0.012$). This difference was statistically highly significant. There was a significant reduction in estimated PASP after balloon mitral valvotomy (BMV) ($P < 0.001$) and after MVR ($P = 0.006$).The mean MVA by planimetry in patients with MS was 0.90 ± 0.17 and significantly increased after BMV (1.84 ± 0.26; $P < 0.0001$). There was no significant difference in maximum LA area before and after PTMC and MVR ($P = 0.4$). There are no significant differences in PALS after PTMC and after MVR ($P = 0.6$); it is also independent of rhythm ($P = 0.3$).

Variables are summarized in Tables 1 and 2.

Discussion

Atrial function is conventionally assessed by atrial volume which is operator and load-dependent. Moreover, these indices do not accurately evaluate atrial reservoir function. 2D STE allows noninvasive assessment of global LA mechanic.[8-10] Our study showed that PALS is abnormal in patients with MS independent of rhythm; however, other conventional echocardiographic indices of LA function such as LA volume is impaired in these patients, but improvement of PALS after PTMC or MVR is interesting. Improvement of MVA or decrease of PAP is a good indicator of successful BMV, and improvement of PALS could be a new confirmatory tool. In patients with MS, LA pressure

Table 1: Echocardiographic parameters before and after BMV

	Pre- PTMC (*n*=28)	Post- PTMC (*n*=28)	*P*
Positive peak LA strain (%)	5.1±11.6	6.5±17.7	<0.001
PASP (mm/hg)	19.0±51.7	12.2±36.0	<0.001
LVEF (%)	3.7±56.4	3.6±56.3	0.717
LA Area (cm^2)	6.5±31.7	6.6±31.5	0.401
MVA (cm^2)	0.17±0.90	0.26±1.84	<0.001

Table 2: Paired Differences before and after MVR

	Post-MVR (*n*=18)	Pre-MVR (*n*=18)	*P*
Positive peak LA strain (%)	7.4±10.7	11.5±15.9	0.012
PASP (mm/hg)	18.7±49.8	12.8±37.8	0.006
LVEF (%)	4.3±55.5	4.3±55.2	0.210
LA Area (cm^2)	9.8±36.0	8.7±35.7	0.677

is so high, and when high transmitral pressure gradient is reduced by PTMC and MVR, the strain acutely improves and as we show in this study, PALS is a good indicator of LA function even 1 day after treatment of MS independent of the type of treatment modality. In concordance to our study, Caso *et al*. also demonstrated that reservoir function is impaired in MS and the degree of impairment increases with increasing the severity of MS.[7] STE may allow evaluation of the recovery of LA reservoir function. PALS may predict the successful results of PTMC, may provide a simple, useful tool for assessment of atrial function in patients with MS who underwent MVR and PTMC. PTMC and MVR result in rapid improvement of LA deformation. This finding suggests that reduced LA pressure rather than a structural abnormality contributes predominantly to reduced LA mechanical performance in patients with MS.

Limitations

First of all, this study was done in a relatively small group of patients and thus need to be confirmed in larger populations; second, with the lack of long-term follow-up, we cannot judge about the prognostic effect of STE. No information about tissue velocities and time-volume curves of the LV, no information about the LA active emptying fraction for patients with MS before and after therapeutic intervention, and also no correlation between LA volume and LA active emptying fraction.

Conclusions

PALS is impaired in patients with severe symptomatic MS and acutely improve after treatment and may be a good indicator of successful PTMC.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Her AY, Choi EY, Shim CY, Song BW, Lee S, Ha JW, *et al.* Prediction of left atrial fibrosis with speckle tracking echocardiography in mitral valve disease: A comparative study with histopathology. Korean Circ J 2012;42:311-8.
2. Ojaghi-Haghighi Z, Mostafavi A, Moladoust H, Noohi F, Maleki M, Esmaeilzadeh M, *et al*. J Med Imaging Health Inf 2014;4:705-11.
3. Vianna-Pinton R, Moreno CA, Baxter CM, Lee KS, Tsang TS, Appleton CP. Two-dimensional speckle-tracking echocardiography of the left atrium: Feasibility and regional contraction and relaxation differences in normal subjects. J Am Soc Echocardiogr 2009;22:299-305.
4. Ojaghi-Haghighi Z, Mostafavi A, Moladoust H, Noohi F, Maleki M, Esmaeilzadeh M, *et al.* Atrial myocardial deformation properties predict maintenance of sinus rhythm after external cardioversion of recent-onset lone atrial fibrillation: A color Doppler myocardial imaging and transthoracic and transesophageal echocardiographic study. Circulation 2005;112:387-95.
5. To AC, Klein AL. Left atrial function: Doppler and strain. Curr Cardiovasc Imaging Rep 2010;3:276-85.
6. Zito C, Manganaro R, Khandheria B, Oreto G, Cusmà-Piccione M, Todaro MC, *et al.* Usefulness of left atrial reservoir size and left ventricular untwisting rate for predicting outcome in primary mitral regurgitation. Am J Cardiol 2015;116:1237-44.
7. Caso P, Ancona R, Di Salvo G, Comenale Pinto S, Macrino M, Di Palma V, *et al.* Atrial reservoir function by strain rate imaging in asymptomatic mitral stenosis: Prognostic value at 3 year follow-up. Eur J Echocardiogr 2009;10:753-9.
8. Kapoor A, Kumar S, Shukla A, Tewari S, Garg N, Goel P, *et al.* Determinants of left atrial pressure in rheumatic mitral stenosis: Role of left atrial compliance and "atrial stiffness". Indian Heart J 2004;56:27-31.
9. Inaba Y, Yuda S, Kobayashi N, Hashimoto A, Uno K, Nakata T, *et al.* Strain rate imaging for noninvasive functional quantification of the left atrium: Comparative studies in controls and patients with atrial fibrillation. J Am Soc Echocardiogr 2005;18:729-36.
10. Wang T, Wang M, Fung JW, Yip GW, Zhang Y, Ho PP, *et al.* Atrial strain rate echocardiography can predict success or failure of cardioversion for atrial fibrillation: A combined transthoracic tissue Doppler and transoesophageal imaging study. Int J Cardiol 2007;114:202-9.