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Improvement of Subclinical Left Ventricular Dysfunction in Rheumatic Mitral Stenosis After Percutaneous Balloon Mitral Valvotomy (PBMV) - A Cross Sectional Study

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Abstract: ***Till date rheumatic fever is a major concern in the developing countries including India. Mitral valve is most commonly involved in rheumatic carditis. Mitral stenosis (MS) with or without regurgitation so far is the commonest lesion. Clinical left ventricular (LV) dysfunction is rare in rheumatic mitral stenosis unless they are associated with aortic valve lesion, concomitant coronary artery disease (CAD), or tachy - cardiomyopathy. Numerous studies have shown subclinical LV dysfunction is common in MS patients that can be identified by Strain echocardiography (SE). We have conducted a cross - sectional study in IPGMER, SSKM Hospital a tertiary care cardiology centre in Kolkata to evaluate improvement of subclinical LV systolic dysfunction by global longitudinal strain (GLS) before and after balloon mitral valvotomy (BMV). The main aim of our study was whether PBMV is enough to improve subclinical LV dysfunction so that need of strain echocardiography can be reemphasized.***

Keywords: Mitral valve stenosis, Rheumatic heart disease, Left Ventricle systolic function, strain echocardiography, Subclinical LV dysfunction

1. Introduction

Rheumatic heart disease (RHD) certainly involves mitral valve, either alone or in combination with other valves. It is caused by group A beta haemolytic streptococcal pharyngitis in genetically susceptible individual in the age group between 5 to 15 years. RHD is disease of lower socioeconomic class although development of carditis is result of complex interaction between host, agent and environment. Autoimmunity plays the key role for cardiac manifestation. Progressive valve damage, leaflet thickening, commissural calcification are the key histopathological features of rheumatic mitral stenosis. The left ventricular end diastolic pressure (LVEDP) often increases due to presence of certain conditions like aortic valve disease, coexisting mitral regurgitation (MR), cardiomyopathy, systemic and ischaemic heart disease

Mitral valve stenosis (MS) is the most prominent indication for chronic rheumatic valvulitis. It can be associated with mitral or aortic regurgitation. Pure tricuspid or pulmonary valve involvement is rare. LV dysfunction is rare in pure mitral stenosis. (1)
The left ventricular end diastolic pressure (LVEDP) often increases due to presence of certain conditions like aortic valve disease, coexisting mitral regurgitation (MR), cardiomyopathy, systemic and ischaemic heart disease eventually leading to LV dysfunction. (2)

Percutaneous balloon mitral valvotomy (PBMV) is the main treatment modality in mitral stenosis when valve area is less than 1 cm2. It can be done in higher valve area associated with Pulmonary hypertension (PAH) or new onset atrial fibrillation (AF). Wilkins score commonly used for assessment of mitral valve before PBMV. Mobility of mitral leaflet, calcification, sub valvular apparatus and leaflet thickening are the four parameters assessed in this score. Wilkins score of less than 8 out of 16 considered to be favourable valve morphology for PBMV whereas any score more than 12 should be sent for surgery. (3)

Main limitation of Wilkins score is it does not address bicommissural calcification which is very common in Indian population and is considered as contraindication for PBMV.

Short and long term effect of PBMV over LV function can be assessed by conventional echocardiography along with strain echocardiography. GLS of left ventricle (LV) and right ventricle (RV) is commonly used. (4)

In our study we tried to evaluate that is there any improvement of global longitudinal strain (GLS) of LV after successful PBMV. (5)

2. Material and Methodology

Patient population and eligibility criteria
The patients included in this study were aged between 18 to 45 years who visited Cardiology OPD, IPGMER and S. S. K. M Hospital from July, 2017 to December, 2018 with critical rheumatic mitral stenosis (MS) and were eligible for PBMV as per Wilkins Score. Prior enrolment in the study, proper written informed consents were obtained from the patient or the relatives.

Inclusion Criteria:

Patients (18 - 45 years) diagnosed with rheumatic heart disease with severe mitral stenosis (MS). Severity of MS was determined by

1) Mitral valve area (MVA) < 1cm2 calculated by planimetric method in parasternal short axis view (PSAX) of conventional 2D echocardiography.
2) Mean pressure gradient across mitral valve > 10 mm of hg

Selection of patient for PBMV eligibility was done by Wilkins Score.

Exclusion criteria:

1) Bicommissural calcification
2) Clinically significant mitral regurgitation (MR)
3) Atrial Fibrillation (AF)
4) Thrombus in left atrium (LA) or left atrial appendages (LAA)

Study Design

This was a cross - sectional, observational study where 100 patients aged between 18 to 45 years fulfilling inclusion criteria were enrolled in the study.

Pre - PBMV Echocardiographic data were taken (both 2D and strain echo) and recorded.

PBMV was done via transeptal puncture using Inoue balloon. Balloon sizing was done based on the height of the patient. Septal Puncture was done in fluoroscopic left anterior oblique (LAO), lateral, or anteroposterior (AP) view. Trans mitral gradient was measured before and after balloon inflation. Procedure of PBMV was done under echocardiography and fluoroscopy guidance.

The success of the PBMV procedure was measured by Mitral valve area (MVA) >1.5 cm2 measured by 2D echocardiography and reduction of pressure gradient across mitral valve >50% with no significant mitral regurgitation. In majority of cases after balloon mitral valvotomy there is only single commissural split. Rarely we have seen bicommissural split with single Inoue balloon inflation.

After successful PBMV follow up echocardiographic evaluation was done using 2D echocardiography and strain echocardiography (Global longitudinal strain of LV) at an interval of 24 hours, 1 month and 6 months.

Study Parameters.

All eligible patients underwent an echocardiographic examination using the GE Vivid6 system (GE Vingmed Ultrasound AS, Horten, Norway) with a 4 - MHz transducer.2Dechocardiography images were obtained from LV apical 4 - chamber (4C), LAX (long axis) and 2 - chamber (2C) views. Left ventricular end diastolic diameter (LVEDD), Left ventricular end systolic diameter (LVESD), Ejection fraction (EF), fractional shortening (FS%) and Mitral annular plane systolic excursion (MAPSE) was taken for each patient.

M mode data was obtained from parasternal long axis view (PLAX) at the level of mitral valve. Mitral valve morphology, leaflet thickening, degree of calcification, mitral valve area were also evaluated using 2D method.

Strain Echocardiography parameters, Strain measurements were taken as the peak longitudinal strain (LS) for four chamber (4C), LAX (Long axis), and Apical two chamber (A2C) view. Global strain rate was calculated by calculating the average of these three strain value. (Figure 1)

Segmental longitudinal strain measurement was performed using the 2D - speckle tracking echocardiography (STE) method. GLS was calculated by automatically averaging the strain values of all myocardial segments obtained by the device. Segmentation of LV myocardium was based on the American Heart Association's (AHA) 17 - segment model as follows: (1) Basal anterior (2) Basal anteroseptal (3) Basal inferoseptal (4) Basal inferior (5) Basal inferolateral (6) Basal anterolateral (7) Mid anterior (8) Mid anteroseptal (9) Mid inferoseptal (10) Mid inferior (11) Mid inferolateral (12) Mid anterolateral (13) Apical anterior (14). Apical septal (15) Apical inferior (16) Apical lateral (17) Apex (Figure 2)

Echocardiography was done in supine position without breath holding. Heart rate during echo was less than 80 beat per minute.

Every study parameters of 2D ECHO and GLS of LV were taken over three cardiac cycle. Cut of value of LV dimensions was as per criteria laid down by American Society of Echocardiography (ASE).

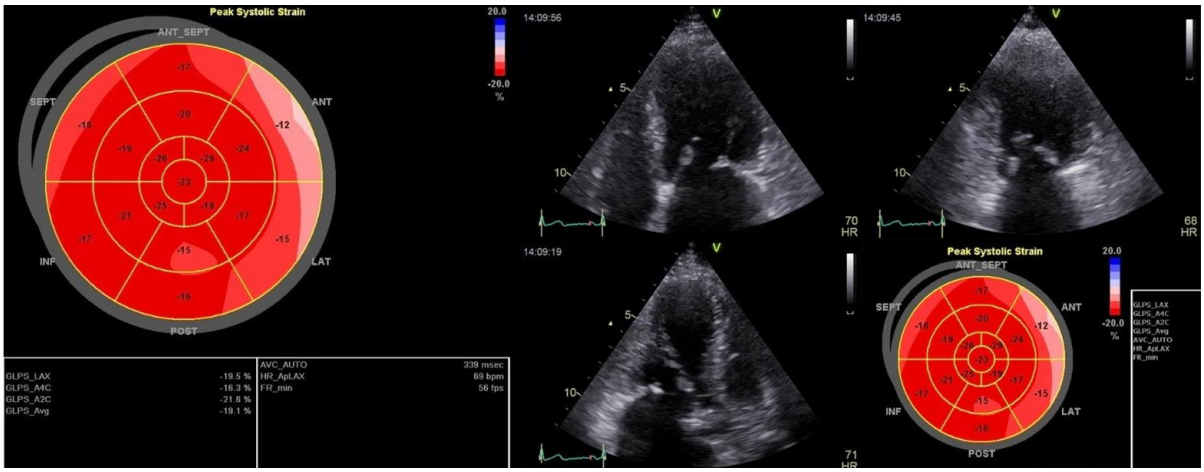

Figure 1: Global longitudinal strain (GLS) of LV in RHD severe MS. Despite good global LV strain value segmental strain in basal anterior and lateral wall of LV has reduced (pink area in bull's eye)

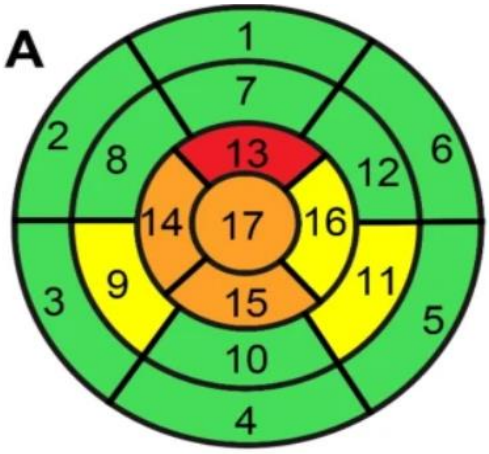

Figure 2: 17 LV segment (green segments has significant lower value of strain in patients with mitral stenosis as compared to control)

Statistical analysis

The statistical analysis of the data was done using SPSS (version 24.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 5 software. Data was summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. One - way analysis of variance (one - way ANOVA) was used to compare means of three or more samples for numerical data (using the F distribution). P - value ≤ 0.05 was considered as statistically significant.

3. Result

Baseline Characteristics

The average age of 100 participants was 35.24 ± 9.4 years with a minimum age of 18 years and maximum of 58 years. The median age of the study participants was 34 years The average BMI of the participants was 28.8 ± 2.3 Kg/m2. The maximum and minimum BMI of the group were 30.6 Kg/m2 and 18.6 Kg/m2 respectively with a median BMI of 24.1 Kg/m2 (Table I). 58% of the population was male and rest 42% was female.

Table 1: Age and BMI distribution of total 100 patients enrolled for the study

	Number	Mean	SD	Minimum	Maximum	Median
Age	100	35.2400	9.3885	18.000	58.0000	34.0000
BMI	100	23.8360	2.3035	18.6000	30.6000	24.1000

Age distribution of the study population (Table II)

Age distribution	Frequency	Percent
≤20	2	2.0%
21- 30	32	32.0%
31- 40	34	34.0%
41- 50	26	26.0%
51- 60	6	6.0%
Total	100	100.0%

Table III: Distribution of Gender

Gender	Frequency	Percent
Female	58	58.0%
Male	42	42.0%
Total	100	100.0%

There is significant improvement in LVEDD (LV end diastolic diameter) and LVESD (LV end systolic diameter) after PBMV (table IV and V). Although change in LVESD failed to meet the criteria of statistical significance.

Table IV: Distribution of mean LV EDD: Group

		Number	Mean	SD	Minimum	Maximum	Median	p- Value
LV EDD	Pre- Op	100	43.6280	4.5521	34.9000	52.3000	43.7000	<0.0001
	After 24 hrs	100	44.0400	4.3186	34.9000	51.9000	44.6000	
	After 1 month	100	45.0800	3.8851	35.5000	51.9000	46.0000	
	After 6 months	100	46.2920	3.8046	37.0000	53.4000	46.1500	

Table V: Distribution of mean LVESD: Group

		Number	Mean	SD	Minimum	Maximum	Median	p- Value
LVESD	Pre- Op	100	27.8200	4.4725	20.6000	38.5000	28.6500	0.3960
	After 24 hrs	100	28.0880	4.3234	20.5000	38.7000	28.7000	
	After 1 month	100	28.4480	4.1846	21.3000	37.5000	28.7000	
	After 6 months	100	28.8060	4.2468	20.8000	37.6000	29.4000	

Change in the LVESD is not statistically significant in the study population (Table Va)

		Number	Mean	SD	Minimum	Maximum	Median	p- Value
MAPSE	Pre- Op	100	11.2840	1.0907	9.4000	14.0000	11.3000	<0.0001
	After 24 hrs	100	11.9470	1.3094	9.5000	15.0000	12.0000	
	After 1 month	100	13.2420	1.4659	10.5000	18.0000	13.1000	
	After 6 months	100	14.7560	1.5787	11.0000	18.0000	14.9500	

Improvement seen in mitral annular plane systolic excursion (MAPSE) after PBMV upto 6 month follow up. (Table VI)

		Number	Mean	SD	Minimum	Maximum	Median	p- Value
GLS	Pre- Op	100	-16.4240	1.6995	-20.7000	-12.9000	-16.5000	<0.0001
	After 24 hrs	100	-17.4860	1.6318	-21.2000	-14.1000	-17.6000	
	After 1 month	100	-17.9720	1.7786	-22.3000	-14.2000	-18.0000	
	After 6 months	100	-19.3640	1.3759	-22.4000	-16.5000	-19.3000	

Significant improvement of Global longitudinal strain (GLS) median value after 6 month follow up of PBMV. (Table VII)

		Number	Mean	SD	Minimum	Maximum	Median	p- Value
EF	Pre- Op	100	58.9000	5.6147	50.0000	69.0000	59.5000	0.0001
	After 24 hrs	100	59.3600	5.3664	51.0000	69.0000	60.0000	
	After 1 month	100	57.3200	6.1314	46.0000	69.0000	57.0000	
	After 6 months	100	55.8200	6.4470	44.0000	69.0000	54.5000	

Distribution of mean LV ejection fraction (EF) – (Table VIII)

4. Discussion

Subclinical LV dysfunction is not rare in hemodynamically significant MS. Postero - lateral part of basal LV segment is frequently affected. Chronic underfilling of LV due to MS leads to ultrastructural change in the myocardium, initiate LV fibrosis and progress to subclinical LV dysfunction. (6)

In our study there was significant improvement in the all echo - cardiographic parameters after successful PBMV. Majority of the patients were young with near equal gender distribution. Improvement in LV end diastolic dimension (LVEDD) was statistically significant. Statistically significant improvement seen in LVEF, MAPSE as well as Global longitudinal strain (GLS).

Main limitation of this study was relatively small sample size. We could not follow up the patients for longer period of time. Unfortunately this study did not include Left atrial (LA) and Right ventricular (RV) strain. Both LA and RV strain is very much relevant in the background critical mitral stenosis. Numerous studies has been conducted across the globe regarding the LA and RV strain echocardiographic pattern in mitral stenosis. (7)

5. Conclusion

Contrary to popular belief subclinical LV dysfunction generally present in maximum critical MS patients. This can be readily picked up by use of strain echocardiography by speckle tracking method. Follow up of these patient is important after transcatheter intervention.

We need more randomized controlled trial (RCT) regarding proper use of strain echocardiography in MS patients so that much more clear understanding of LV physiology can be obtained.

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