Effect of Subvalvular Changes on Mitral Valve Leaflets Excursion after Percutaneous Trans-venous Mitral Commissurotomy

Md. Abdul Mannan, AAS Majumder, Solaiman Hossain, Chandan Kumar Shaha, Md. Abul Khair, Mohammad Ullah, Md. Toufiqur Rahman

Department of Cardiology, National Institute of Cardiovascular Diseases and Hospital, Dhaka.

Key Words :
Mitral stenosis, Valvuloplasty, PTMC.

Abstract:

Background: *Aim of our study was to predict the effect of subvalvular changes on mitral valve leaflets excursion in a patient with mitral stenosis following percutaneous trans-venous mitral commissurotomy.*

Methods: *Total of 60 patients of severe mitral stenosis were enrolled in the study. Transthoracic echocardiography was done on the day before percutaneous trans-venous mitral commissurotomy and 24-48 hours after percutaneous trans-venous mitral commissurotomy. Subvalvular area, anterior and posterior leaflets excursion were recorded.*

Results: *Following percutaneous trans-venous mitral commissurotomy there were significant increase in anterior leaflet excursion from 1.8 ± 0.2 to 2.2 ± 0.2cm (p=<0.001), posterior leaflet excursion from 1.5±0.2to1.8 ± 0.2cm (p<0.001) . Subvalvular splitting areas was from 0.8 ± 0.2 to1.2 ± 0.2cm²(p=<0.001). Pulmonary arterial systolic pressure and left atrial diameter were significantly reduced respectively 55.6 ± 19.5 vs. 31.6 ± 9.5 mmHg,(p < 0.001) and 4.3 ± 0.6 cm vs. 3.8 ± 0.6 cm (p < 0.001). Post percutaneous trans-venous mitral commissurotomy subvalvular splitting area was found to be the predictor of increased excursion of both anterior and posterior mitral leaflets.*

Conclusion: *percutaneous trans-venous mitral commissurotomy is associated with immediate significant changes in mitral valve morphology in terms of splitting of fused mitral commissures, increased valve leaflets excursion and splitting of the subvalvular structures. Post percutaneous trans-venous mitral commissurotomy subvalvular splitting area was found to be the predictor of increased excursion of both anterior and posterior mitral leaflets.*

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Introduction:

Rheumatic heart disease is the most common cause of mitral stenosis (MS). Rheumatic heart disease is a chronic manifestation of rheumatic carditis, which occurs in 60% to 90% of cases of rheumatic fever. The annual report by the World Heart Federation estimated 12 million people are currently affected by rheumatic fever and rheumatic heart disease worldwide and higher incidence rates are reported in the Southern Pacific Islands. Several studies were on the prevalence of rheumatic heart disease reporting 0.14/1000 in Japan, 1.86/1000 in China, 0.5/1000 in Korea, 4.5/1000 in India.[1] A community–based study showed that the prevalence of rheumatic heart disease is1.3/1000 in rural Bangladesh.[2] Among the management of MS, percutaneous transvenous mitral commissurotomy (PTMC) emerged as a safe and effective procedure for the treatment of symptomatic MS in a selected group of patients.[3] PTMC has become an accepted alternative to surgical commissurotomy, especially in young patients with pliable valves leading to comparable immediate and long term results. Patients with a good score obtain better initial and long term results, but those with less favourable profile may still have sustained heamodynamic and symptomatic relief.[4] So patient selection depends upon factors which are vital for favourable immediate and long term outcome of successful PTMC. Both clinical and echocardiographic assessments are important before performing PTMC. The long term outcome after this procedure can be predicted from baseline clinical and valvular

Address of Correspondence: Dr Md. Abdul Mannan, General Hospital, Sirajgonj, Bangladesh. Email-drmannan80@gmail.com

characteristics.[5] Echocardiographic score 8 or less are the best candidates for PTMC. Patients with echocardiographic scores of more than 8 have a 56% chance of having a suboptimal immediate result with PTMC. If the score is more than 12 it is unlikely that PTMC will produce a good immediate or long term result.[6] PTMC was found to be associated with splitting of the fused mitral commissures with a subsequent increase in mitral valve area (MVA).[7] However, not all patients with commissural splitting after the procedure were found to have an optimal MVA.[8] This suggested that the mechanism of successful PTMC may be more complex than reported previously. Short term improvement in MVA and symptoms that occur when commissures are not split may be attributed to other mechanism, such as improvement of leaflets mobility secondary to disruption of the diseased submitral tissue.[9] Assessment of the other changes produced in mitral valve morphology may have an adjuvant value to the conventional measurement of the MVA in the morphologic assessment of the mitral valve function. Only few reports referred to the improvement in valve mobility.[10] Evaluation of factors those determine the extent of valve leaflets mobility or excursion is necessary to detect heamodynamic changes with improved mitral leaflets excursion and outcome of PTMC.

Material and Methods:

This prospective observational comparative study is done in National Institute of Cardiovascular Diseases, Dhaka, from September, 2013 to March, 2014. 60 patients were selected from MS with planimetry mitral valve area <1.0 cm2, Wilkin's score d"8 and isolated MS or with grade I mitral regurgitation. Transthoracic echocardiography was done on the day before PTMC, immediately after PTMC and 24-48 hours after PTMC by one expert. Standard echocardiographic measurements were taken and averaged in 4 cardiac cycles. Mitral valve leaflets excursion is measured in parasternal long axis view, at maximum doming in early diastole. A line was drawn at the level of mitral valve annulus (at the base of the leaflets), and then 2 perpendicular lines were dragged from the tip of the leaflets on that line. The distance from tip to the perpendicular line is the excursion and was measured in cm. Subvalvular splitting area was assessed by measuring the area subtended by the papillary muscles and chordaetendinae below the mitral valve, in early diastole at maximum doming of valve leaflets in apical long axis view.[11] It was measured in square cm by planimetry. PTMC was done with all aseptic precaution through femoral approach under local anesthesia by the ante grade trans-septal approach using an Inoue balloon technique and a stepwise dilatation strategy. Successful PTMC was defined as post valvuloplasty valve area > 1.5 cm2 or ≥50% increase in the mitral valve area without significant complications.[12]

Mitral valve leaflets excursion

It was assessed by measuring the anterior and posterior leaflets excursion.[13] To measure the excursion in parasternal long axis view, at maximum doming in early diastole, a line was drawn at the level of mitral valve annulus (at the base of the leaflets), and then 2 perpendicular lines were dragged from the tip of the leaflets on that line. The distance from tip to the perpendicular line is the excursion and was measured in cm.

Subvalvular splitting area

It was assessed by measuring the area subtended by the papillary muscles and chordaetendinae below the mitral valve, in early diastole at maximum doming of valve leaflets in apical long axis view.[11] It was measured in square cm by planimetry.

Statistical Analysis

Data was expressed as mean ±SD. Analysis is employed the student's t-test to determine the significance of difference before and after PTMC in patients with MS. To show the relationship between the variables Pearson correlation analysis is performed. Linear regression analysis was used to study the predictors of post-PTMC leaflet excursion. P-value <0.05 is considered statistically significant. All the data entry and analysis was done by using SPSS and NCSS software program.

Results:

Demographic characteristics:

One-third (33.3%) of the patients was below 30 years of age and two-third (66.7%) was 30 or more

than 30 years of age. The mean age of the patients was 29.7 ± 7.7years and the lowest and highest ages were 13 and 46 years respectively. Sixty percent of the patients were female. Majority (90%) of patients was normal in terms of BMI and 10% were overweight (Table-I).

Table-I

Distribution of patients by demographic characteristics (n= 60).

Demographic characteristics	Frequency	Percentage
Age (years)		
<30	20	33.3
≥30	40	66.7
Sex		
Male	24	40.0
Female	36	60.0
BMI (kg/m^2)		
<25 (normal)	54	90.0
≥25 (over weight & obese)	06	10.0

•Mean age = (29.7 ± 7.7) years; range = (13 – 46) years.

Table-II

Percentage of distribution patients by pattern of complications during the procedure (n=60).

Pattern of complications	Number	%
Severe MR (grade III)	1	1.7
MR grade II	6	10.0
MR grade I	7	11.66
Local vascular complication	7	11.66
Pericardial effusion	1	1.7

Considering the procedural complication, 01 patient (1.7%) developed severe mitral regurgitation (MR) grade III, 06 patients (10%) MR grade II, 07 patients (11.66%) MR grade I. The Vascular complications e.g. hemorrhage, hematoma developed in07 patients (11.66%) and 01(1.7%) patient developed pericardial effusion.

Echocardiographic findings before and after PTMC

Pulmonary arterial systolic pressure, left atrial diameter and transmitral peak pressure gradient were significantly reduced after PTMC (55.6 ± 19.5 vs. 31.6 ± 9.5 mmHg, p < 0.001; 4.3 ± 0.6 cm vs. 3.8 ± 0.6 cm, p < 0.001; 2.9 ± 0.5 vs. 2.7 ± 0.5 cm, p < 0.001 and 24.3 ± 7.2 vs. 10.4 ± 3.4 mmHg, p < 0.001. On the other hand, mitral valve area, anterior mitral leaflet excursion, posterior mitral leaflet excursion, subvalvular splitting score significantly increased after PTMC compared to their baseline figures (p < 0.001) (Table-III).

Table-III

Comparison of echocardiographic findings before and after PTMC

Echocardiographic findings	Group		p-value
	Before PTMC	After PTMC	
Anterior mitral leaflet excursion (cm)	1.8 ± 0.2	2.2 ±0.2	<0.001
Posterior mitral leaflet excursion (cm)	1.5 ± 0.2	1.8 ± 0.2	<0.001
Mitral valve area (cm^2)	0.8 ± 0.1	1.7 ± 0.2	<0.001
Subvalvular splitting area (cm^2)	0.8 ± 0.2	1.2 ± 0.2	<0.001
Transmitral peak Pressure gradient (mm of Hg)	24.2±7.2	10.4 ± 3.4	<0.001
Left atrial diameter (cm)	4.3 ± 0.6	3.8 ± 0.6	<0.001
Pulmonary artery systolic Pressure (mm of Hg)	55.6 ± 19.5	31.6 ± 9.5	<0.001

Paired t-Test was done to analysis of data and Presented as Mean ± SD.

Table-IV

Correlation of mitral valve splitting area and other echocardiographic parameters with anterior mitral leaflet excursion following PTMC

Correlated variables Independent(X)	Dependent (Y)	Correlation co-efficient (r)	p-value
Mitral valve area (cm^2)	Anterior mitral leaflet excursion	0.369	0.004
Subvalvular splitting area(cm^2)	Anterior mitral leaflet excursion	0.469	<0.001
Trans-mitral peak pressure gradient	Anterior mitral leaflet excursion	-0.392	0.002

Table-VI

Correlations of mitral valve splitting area and other echocardiographic parameters with posterior mitral leaflet excursion following PTMC

Correlated variables		Correlation co-efficient(r)	p-value
Independent(X)	Dependent (Y)		
Mitral valve area (cm^2)	Posterior mitral leaflet excursion	0.293	0.023
Subvalvular splitting area (cm^2)	Posterior mitral leaflet excursion	0.393	0.002
Trans-mitral peak pressure gradient mm of Hg	Posterior mitral leaflet excursion	-0.314	0.014

Table-VII

Linear predictors of improved anterior leaflet Excursion

Independent variables	Standardized coefficients (Beta)	95% CI	p-value
Mitral valve area (cm^2)	0.093	0.052– 0.140	0.550
Subvalvular splitting area (cm^2)	0.231	0.061– 0.433	0.037
Transmitral pressure gradient (mm of Hg)	-0.215	(-0.120) – (-0.311)	0.027

Table-VIII

Linear predictors of improved posterior leaflet Excursion

Independent variables	Standardized coefficients (Beta)	95% CI	p-value
Mitral valve area (cm^2)	0.190	0.095– 0.416	0.214
Subvalvular splitting area (cm^2)	0.224	0.183– 0.373	0.010
Transmitral pressure gradient (mm of Hg)	-0.197	(-0.098) – (-0.264)	0.036

Discussion:

Over the past several years PTMC has become an accepted alternative to surgery in the treatment of patients with MS. 3–4 previous studies have confirmed that this procedure is highly successful with a low complication rate and significant short and long term improvement in both hemodynamics and patient symptoms.[14] The present study demonstrates that PTMC produces significant morphologic and hemodynamic changes in the mitral valve.

We found that PTMC produced a significant increase in MVA and significant splitting of both mitral commissures. It was reported in the early pathologic studies that subvalvular fibrosis with fusion and shortening of the chordaetendinae causes obliteration of the interchordal spaces which are considered as secondary orifices for blood flow, below the main orifice formed by the leaflets. Commissural fusion causes valvular stenosis and is affected in 76% of cases. Subvalvular fibrosis causes a second level of obstruction to blood flow "subvalvular" and is present in 39% of cases of MS.[15]

In our study PTMC caused a significant improvement in valve mobility, reflected as increase in both anterior and posterior leaflets excursion. In MS the chordae are occasionally retracted that the leaflets appear to be inserted directly into the papillary muscles, so that the interchordal spaces are entirely obliterated. They recommended that mitral commissurotomy on such a valve must include splitting of the papillary muscles as well as the commissures.[16] PTMC more closely resembles closed mitral commissurotomy, which has a limited effect on subvalvular apparatus.[9] Nevertheless; the effect of PTMC on the subvalvular apparatus was not well studied.

In our study, we used the subvalvular splitting area as a marker of subvalvular fusion assessed in a quantitative way before and after the procedure. We found this area increased significantly after PTMC. Leaflet excursion was found to increase with increased post-PTMC mitral valve area till the MVA reaches a value around 1.5 cm^2 after which the relationship became non-significant. Also, excursion was determined by post-procedural subvalvular splitting area, and transmitral pressure gradient. . It was supposed that the valve mobility is the result of all the pathologic processes in the mitral valve apparatus that results in stenosis rather than an independent variable. So, it is affected by the degree of commissural fusion, leaflet thickness, calcification and subvalvular fusion.[17] Mitral valve area and subvalvular splitting area were observed to be positively correlated with both mitral leaflet excursion, while transmitral pressure gradient was found to be negatively correlated to both mitral leaflet excursion. Linear regression analysis showed that post-PTMC subvalvular splitting area and transmitral pressure gradient were found to be the independed predictor of increased excursion of both anterior and posterior mitral leaflets.

Conclusion:

percutaneous trans-venous mitral commissurotomy caused splitting of fused mitral commissures, increased MVA, increased leaflets excursion and splitting of the subvalvular structures. The increased in leaflets excursion after PTMC is determined by several morphologic and hemodynamic changes produced in the valve. Post-PTMC subvalvular splitting area was found to be the independed predictor of increased excursion of both anterior and posterior mitral leaflets.

Conflict of Interest - None.

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