Original Article

Effect of Successful Percutaneous Transvenous Mitral Commissurotomy on Pulmonary Function

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Abstract:

A total of 58 patients of severe mitral stenosis with Wilkins score < 10 were studied, all of them underwent PTMC. Spirometry and peak expiratory flow rate were done before and after PTMC. A follow up echocardiographic assessment of successful PTMC and pulmonary artery systolic pressure were taken. Two patients died of PTMC related procedural complications. There was no dropout. Hemodynamic measurements obtained by echocardiography showed improvement of mean mitral valve area from 0.764 ± 0.1257 cm^2 to 1.404 ± 0.1194 cm^2 after PTMC (p < 0.001). Transmitral peak pressure gradient decreased from 26.43 + 5.62 mmHg to 11.36 + 2.40 mmHg after PTMC (p < 0.001). Pulmonary artery systolic pressure was decreased from 57.73 ± 17.03 mmHg to 31.27± 8.30 mmHg after the procedure (p < 0.001). pulmonary functions - The mean FEV_1 was increased from 60.18 ± 13.054 to 78.32 ± 11.874 after PTMC (p<0.001). The mean FVC was 53.80+ 12.313 before PTMC, which significantly improved to 68.57 + 11.662. PEF also showed an improvement from 223.75 + 62.3215 to 372.05 + 62.2. (p<0.001).

Key Words: Mitral stenosis, PTMC, Pulmonary function test

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Introduction:

Many patients of mitral stenosis in Bangladesh present with respiratory symptoms, and are often treated as bronchial asthma or chronic obstructive airway disease. Impaired pulmonary function may be an important contributor to overall morbidity and mortality in our country, where the patients often present late. In a more recent community based study on 5925 rural Bangladeshi children aged 5-15 years, the prevalence of rheumatic fever and rheumatic heart disease was found to be 1.2 per 1000 for rheumatic fever defined by Revised Jones Criteria and 1.3 per 1000 for Doppler echocardiography-defined rheumatic heart disease.[1]

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Although the pathogenesis of pulmonary function abnormality in mitral stenosis is not fully known, it is certain that the chronic changes in pulmonary circulation secondary to increased pulmonary venous pressure and reflex pulmonary artery vasoconstriction cause alterations in pulmonary vessels and in the composition of lung tissue.[2] Accumulation of water, proteins, and proteoglycans in the interstitium has been acknowledged in this condition. These interstitial changes are the basis of the clinical manifestations of mitral stenosis and can be detected by pulmonary function tests.[3] Several propositions are known to contribute to the pathogenesis of airflow obstruction in patients with mitral valve disease. Hypertrophied and hyperplastic airway smooth muscle and increased wall thickness are also heightened along with bronchial hyper-reactivity.[4]

Thus, the effect is completely mechanical one and depends on the degree of stenosis of mitral valve. The major act of affray comes into account from several studies are reduction in pulmonary compliance ventilation-perfusion mismatch,

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reduction in diffusion capacity, increased "pulmonary capillary blood volume" and hyperventilation in exercise in relation to the oxygen uptake.[2,4,5]

Majority of ventilatory functions impairment caused by hemodynamic alteration are mainly reversible.[2] In the present study, the pulmonary functions and echocardiography were done before and after PTMC in an order to observe the effect of PTMC on lung function test in severe mitral stenosis patients.

Materials and methods:

58 patients with severe mitral stenosis eligible for percutaneous transvenous mitral commissurotomy (PTMC) were enrolled with informed written consent. Concomitant mild aortic stenosis was taken under consideration. Exclusion criteria included chronic obstructed airway disease (COPD), bronchial asthma (BA), interstitial lung disease, smoker, left ventricular EF <55%, neurological disease and other valvular heart diseases, spinal deformities, age >40 years. Lung causes were excluded by taking history, chest x-ray and pulmonary function test and high resolution computed tomography of chest where needed. Demographic data such as, age, sex, height (cm), weight (kg) and BMI (kg/m^2) were also recorded. Symptoms were assessed by New York Heart Association (NYHA) functional status.

Transthoracic M-mode, two-dimensional and Doppler echocardiography was done in all patients before and after PTMC. Diagnosis was confirmed by two-dimensional surface area and Doppler ultrasound-derived pressure half-time methods. Wilkins score was applied to assess the Mitral valve morphology, the degree of mitral regurgitation was assessed by Doppler study. Patients with favorable morphology of mitral valve were selected, and a transesophageal echocardiography was performed to exclude the presence of left atrial thrombus in selected patients. Pulmonary arterial systolic pressure was measured.

Spirometry and measurement of peak expiratory flow rate was done in every patient, 2 to 3 days before and 7 days after PTMC. Spirometry was performed according to the American Thoracic Society recommendations. The following parameters were recorded: FVC, FEV_1, FEV_1/FVC, and peak expiratory flow (PEF). FVC and FEV_1 was expressed as percentage predicted and PEF expressed as liter/min.[5,6,7,8]

Only mitral stenosis patients with favorable valve morphology (Wilkins score ≤10) were selected for PTMC; PTMC was done by a transseptal antegrade technique using the Inoue balloon.

Successful commissurotomy was considered as an MVA >1.5 cm^2 or >50% increase in mitral valve area in absence of complications including severe mitral regurgitation (>grade II) and/or a large atrial septal defect (<1.5:1 left-to-right shunt) which was confirmed by both auscultatory method and Doppler echocardiography.[9]

Results:

58 patients were enrolled in this study but 2 patients died due to procedural complications. So, calculation was done on 56 patients. The majority of the respondents were female 46 (82.14%), and the remaining 10 (17.86%) were male. Among the female patients, maximum were > 20 year age group (n=34, 60.71% of total). The majority of the male subjects (n=8, 14.29%) were above 20 years. (Table I)

Table-I

Distribution of the study subjects by age and sex. (n=56)

Age group	Sex		Total
	Male	Female	
<20 years	23.57%	1221.43%	1425%
>20 years	814.29%	3460.71%	4275%
Total	1017.86%	4682.14%	56100.0%
Mean + SD			28.76 ± 7.2

Before PTMC, 36 patients (64.3%) patient were in NYHA class II, 19 patients (33.9%) were in NYHA class III. After successful PTMC, majorities (37 patients, 66.1%) switched over to NYHA class I and remaining 18 patients (32.1%) were in NYHA function class II. (Table II)

Table-II

Distribution of patients by NYHA functional class (n = 56)

NYHA	Before PTMC		After PTMC	
class	Frequency	Percentage	Frequency	Percentage
I	0	0	37	66.1
II	36	64.3	18	32.1
III	19	33.9	1	1.8
IV	1	1.8	0	0
Total	56	100.0	56	100.0

The mean mitral valve area increased from 0.764 ± 0.1257 cm^2 to 1.404 ± 0.1194 cm^2 after PTMC ($p < 0.001$). Transmitral peak pressure gradient decreased from 26.43 + 5.62 mmHg to 11.36 + 2.40 mmHg after PTMC ($p < 0.001$). Mean left atrial diameter (mm) before and after PTMC were 47.23 ± 5.35 mm and 40.18 ± 5.557 mm respectively ($p < 0.001$). Pulmonary artery systolic pressure increased from 57.73 ± 17.03 mmHg to 31.27± 8.30 mmHg after the procedure ($p < 0.001$). (Table III)

Almost all the patients had restrictive type of pulmonary function and only 2 patients showed obstructive pattern. The mean FEV_1 was 60.18 ± 13.054% before PTMC, which increased to 78.32 ± 11.874% after PTMC ($p < 0.001$). The mean FVC improved from 53.80+ 12.313% to 68.57 + 11.662% ($p < 0.001$). PEF also showed an improvement from 223.75 + 62.3215 l/min to 372.05 + 62.2 l/min. The statistics shows that, changes of FVC and PEF after PTMC were highly significant ($p < 0.001$). It is noted that, the effect of PTMC on FEV_1/FVC was insignificant ($p = 0.33$). (Table IV)

There was no significant correlation between pulmonary artery systolic pressure and FVC before and after successful PTMC. (Figure 1 and 2)

Table-III

Comparison of echocardiographic findings before and after PTMC (n=56).

Echocardiographic findings	Group		*p* value
	Before PTMC	After PTMC	
Mitral valve area (square cm)	0.764 ± 0.1257	1.404 ± 0.1194	<0.001
Transmitral peak pressure gradient (mmHg)	26.43 ± 5.62	11.36 ± 2.4000	<0.001
Left atrial diameter (mm)	47.23 ± 5.350	40.18 ± 5.557	<0.001
Pulmonary artery systolic pressure (mmHg)	57.73 ± 17.03	31.27± 8.30	<0.001

Paired t- test was done to analyze the data and presented as mean ± SD.

Table-IV

Comparison of pulmonary function test findings before and after PTMC. (n=56)

Pulmonary function test findings	Group		p value
	Before PTMC	After PTMC	
FEV_1	60.18 ± 13.054	78.32 ± 11.874	<0.001
FVC	53.80 ± 12.313	68.57 ± 11.662	<0.001
FEV_1/FVC	112.64 ± 16.292	114.98 ± 12.714	0.330
PEF	223.75 ± 62.3215	372.05 ± 62.200	<0.001

Paired t- test was done to analyze the data and were presented as mean ± SD.

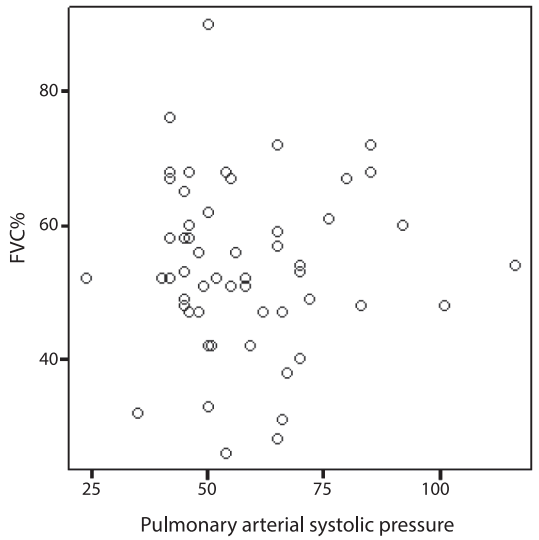

Fig.-1: *Correlation between FVC and PASP before PTMC. (r=000; p>0.05).*

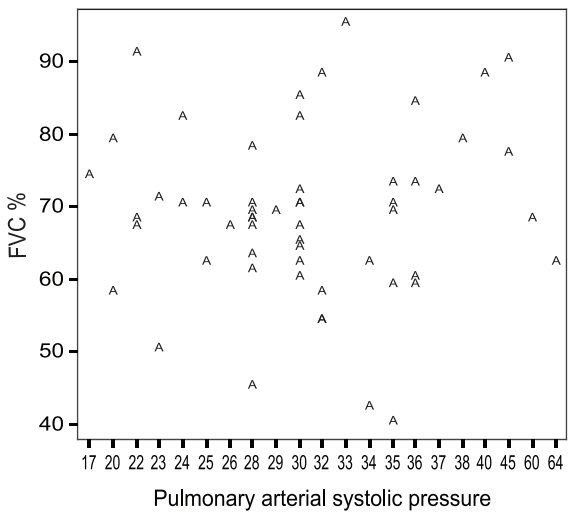

Fig.-2: *Correlation between FVC and PASP after PTMC. (r=0.028; p>0.05)*

Discussion:

Pulmonary function deterioration in mitral stenosis patients has been elucidated previously and certain reversible effects were also demonstrated.[1]

In the present study, young age and female preponderance were observed. All patients had severe mitral stenosis. Seven days after the procedure a dramatic improvement in functional status of all the patients were demonstrated. Patients felt significant relief of dyspnea which was assessed by NYHA class stratification. All hemodynamic parameters including Pulmonary artery systolic pressure (PASP), mitral valve gradient, mitral valve area significantly improved after PTMC those are also supported by other studies.[2,9] A greater reduction of pressure gradient across mitral valve was observed due to increase in mitral valve area.[10]

Different parameters of lung function improved after PTMC. FEV_1 improved significantly post PTMC. FVC and PEF also increased significantly after the procedure. The changes of these parameters were highly significant ($p<0.001$). However, the changes in FEV_1/FVC did not reach statistical significance ($p=0.33$). In another study, there was significant improvement in FVC after PTMC, but FVE_1/FVC change was not significant statistically.[2] In their study, GÌmez-Hospital et al. found significant improvement in FVC and FEV_1, but not in FEV_1/FVC and PEF.[3]

In the current study, out of 56 non-smoker patients, 2 cases had obstructive type airway flow limitations and rest of the patients had restricted type of features on pulmonary function before PTMC. Previous studies found mostly obstructive pattern of defect in pulmonary function, but those involved mostly moderate mitral stenosis patients.[3,11] The restrictive features which are encountered in the chronic stages of lung congestion are attributed to increased interstitial fluid, increased pulmonary blood volume, muscle fatigue, decreased lung compliance, and fibrosis from chronic congestion.[12] Both obstructive and restrictive type of lesions in pulmonary function test were demonstrated in patients with congestive heart failure, as well as, in those with mitral stenosis.[13,14] Simkova and Urbanova found restrictive, as well as, obstructive ventilatory disturbance in patients with mitral stenosis.[11]

Almost all patients got improvement of their ventilatory function after PTMC which is due to alteration of reversible pulmonary haemodynamics. This study showed significant increase in FVC and FEV_1 (percent predicted) and PEF after successful PTMC but there is no significant change in FEV_1/ FVC ratio after PTMC. As a result of improvement on pulmonary hemodynamics, increase in FVC and FEV_1 (percent predicted) may be due to improvement on pulmonary compliance which might be derived from improvement in pulmonary hypertension and decrease in pulmonary venous congestion. It is suggested that the increase in distribution of cardiac output after PTMC to respiratory muscle might change the force of diaphragm and other respiratory muscle causing increase in value of FEV_1 and FVC.[4] In a study, post procedural pulmonary function tests revealed significant improvement of FVC and TLC, i.e. disappearance of restrictive pattern on long term follow up.[11]

Lack of correlation is observed in the present study between FVC and PASP before and after PTMC whereas one study found correlation between the FVC and PASP before PTMC but no correlation after PTMC, probably due to noncorresponding improvement of vital capacity in relation to PASP. There is no striking relationship between cardiac defect and respiratory abnormality and the closest being the inverse one between vital capacity and PASP after PTMC.[5] Maximum breathing capacity correlated poorly with mean pulmonary artery pressure and explanation in favour of this that many of these patients were on prolonged bed rest and thus induced muscular fatigue probably introduced an independent variable factor in the reduction of maximum breathing capacity.

Patients sensed relief of dyspnea immediately after dilatation of the valve corresponding with hemodynamic changes. Significant decrease of NYHA class was detected early after correction of mitral stenosis except in 2 cases where patients died due to procedural complications. Almost all studies mentioned above found symptomatic improvement and decrease in NYHA functional class.

Conclusion:

From this study, it may be concluded that patients with severe mitral stenosis have impaired pulmonary function which is of restrictive type. Symptom often does not correlate with the severity of the disease. Successful PTMC improves pulmonary function, as well as, clinical status. So, PTMC should be done in suitable cases to reduce morbidity in mitral stenosis. Also, assessment of lung function in patients with mitral stenosis may aid in timely decision-making before adopting the interventional strategy of treatment.

References:

1. Ahmed J, Zaman MM, Hasan MMM. Prevalence of rheumatic fever and rheumatic heart disease in rural Bangladesh. *Tropical Doctor* 2005;35(3):160-1.

2. Yoshioka T, Nakanishi N, Okubo S, Konieda T, Ishikura F, Nagata S. Improvement of pulmonary function in mitral stenosis after percutaneous transvenous mitral commussirotomy. *Chest* 1990;98:290-4.

3. GÌmez-Hospital AJ, Cequier A, Romaro PV, et al. Partial improvement in pulmonary function after successful percutaneous balloon mitral valvotomy. *Chest* 2000;117:643-8.

4. Nour MM, Shuhaiber H, Yousof AM. Lung function and severity of mitral stenosis. *Medical Principles and Practice* 1999;8:32-9.

5. Cosby RS, Stowell EC Jr, Hartwig WR, Mayo M. Abnormal ventilatory patterns in mitral stenosis. *Chest* 1956;29:633-40.

6. Albert RK, Spiro SG, Jett JR. *Comprehensive Respiratory Medicine*. St Louis: Mosby;1999.

7. American Thoracic Society. Lung function testing: Selection of reference values and interpretative strategies. *Am Res Respir Dis* 1991;144:1202-18.

8. Hankinson JL, Odencrantz JR and Fedan, KB. Spirometric reference values from a sample of the general U.S. population. *Am J Respir Crit Care Med.* 1999 Jan;159(1):179-87.

9. Drighil A, Bennis A, Mathewson JW, Lancelotti P, Rocha P. Immediate impact of successful percutaneous mitral valve Commissurotomy on right ventricular function. *Eur J Echocardiogr.* 2008 Jul;9(4):536-41.

10. Illius ZM. *Factors determining hospital outcome of perctaneous transevenous mitral commissurotomy*. MD Thesis. Dhaka:University of Dhaka;2005.

11. Simkova I, Urbanova J. Pulmonary function alteration after correction of mitral stenosis. *Bratiol Lek listy*. 2001;102:32-9.

12. Guzzi M, Pontone G, Brambilla R, Agostoni P, Reina G. Alveolar capillary membrane gas conductance : A novel prognostic indicator in chronic heart failure. *Eur Heart J,* 2002;23(6):467-76.

13. Light WR, George RB. Serial pulmonary function in patients with acute heart failure, *Arch Intern Med*. 1983;143(3):429-33.

14. Palmer WH, Gee JDL, Mills FC, Bates DV. Disturbance of pulmonary function in mitral valve disease. *Canad Med Ass J,* 1963;89:744-50.