Comparative Study of Pulmonary Function Tests before and After Successful Percutaneous Transvenous Mitral Commissurotomy

Hasan Allah Sadeghi MD,* N. Paziraee MD**, M. M. Zahmatkesh MD***, R. Miri MD, H.A. Bassiri MD, A. Sadeghpour MD, N. Samiee MD and F. Noohi MD

Abstract

Backgrounds- Mitral stenosis (MS) causes elevation of left atrial and pulmonary venous pressures. Persistent elevation of pulmonary venous pressure causes anatomical and physiological changes in lung vasculature and tissue, and change in lung volumes thereafter. Studies showed improvement of lung function with improvement of mitral stenosis and decrease in left atrial pressure and pulmonary congestion. This study was performed to evaluate lung volumes before and after percutaneous transvenous mitral commissurotomy (PTMC), including FEV1, FVC, SVC, and their percent and FEF of 25, 50, 75, 25-75 percent and PEFR before and within 48 h after PTMC, and to evaluate correlation of each with valve area.

Methods- 26 from 51 patients with inclusion criteria stayed in the study with non-random consequential selection and the others were excluded. All of the patients had moderate to severe MS, good mitral valve morphology, echo score below 11, and absence of clot in the left atrium. Spirometery was done in all of the patients before and after PTMC and FEV_1, FVC, SVC, $FEF_{25\%}$, $FEF_{50\%}$, $FEF_{75\%}$, $FEF_{25-75\%}$ FEV1/FVC, and PEFR were measured.

Results- There were 26 patients (12 female, 14 male) with a mean age of 38.38 years old, mitral valve area was 0.88 cm^2 before and 1.46 cm^2 after PTMC (mean 0.58 cm^2 increase (p<.000). Mean value of lung volumes and flow changes were: SVC change= 100 ml (p<0.1), FVC=230 ml (p<0.005) , FEV_1=250 ml (p<0.003), $FEF_{50\%}$=0.85 (p<0.004), $FEF_{25\%}$ =0.98 (p<0.003), and $FEF_{25-75\%}$=0.71 (p<0.01). Values for SVC, PEFR, and $FEF_{75\%}$ were not significant.

Conclusion- Mean value of FEV_1, FVC, $FEF_{50\%}$, $FEF_{25\%}$ and $FEF_{25-75\%}$ increased significantly, but SVC, FEF $_{75\%}$ and PEFR had no significant improvement. This may suggest improvement of small airway function due to a decrease in lung congestion ***(Iranian Heart Journal 2009; 10 (3):17-21).***

Key words: percutaneous transvenous mitral commissurotomy ■ pulmonary function tests ■ mitral stenosis ■ spirometery

Abbreviations: PTMC: percutaneous balloon mitral valvotomy; MS: mitral stenosis; FEV_1: forced expiratory volume at first second; FVC: forced vital capacity, SVC: slow vital capacity; PEFR: peak expiratory flow rate; FEF: forced expiratory flow

Mitral stenosis (MS) most often is due to rheumatic valvular heart disease. It causes elevation of left atrial and pulmonary pressures.

Persistently elevated pulmonary venous pressure causes anatomical and physiological changes in lung vasculature and tissues and also changes in the lung volumes thereafter.[1,2]

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*Assistant Professor of Pulmonary Medicine, Shaheed Rajaie Cardiovascular Medical Center, Tehran,
** Internist, Iranian Blood Transfusion Organization, Tehran.
*** Associated Professor, Rasul Akram Complex, Pulmonary Department, Tehran
From the Dept. of Pulmonary Medicine and Cardiology, Shaheed Rajaie Cardiovascular Medical Center, Tehran, Iran
Tel: 021 23922123

The accumulation of proteins and proteoglycans has been reported in the interstitium of the lungs in these patients.[3] These anatomical changes in the lung parenchyma are the basis of functional lung disorders in these patients and it is possible to evaluate them by spirometery.[4-6]

Surgical correction was the only way of treatment in these patients in the past, but with the introduction of percutaneous transvenous mitral commissurotomy (PTMC), it has become possible to correct MS in a less invasive manner. Lung function studies in MS patients after surgical correction show an increase in the lung function and hemodynamics, proportionate to the level of decrease in transvalvular and pulmonary venous pressure.[7-9] But in surgical cases, volume changes are affected by the surgical technique, the type of thoracotomy, bypass, decrease in valvular gradient and venous pressure, and probably other factors. It is difficult to evaluate each factor separately.[10,11]

With PTMC, no interaction with the lung function would occur and data is directly in accordance with pressure and volume changes, not with other confounding variables which are present in surgical cases.[12,13]

PTMC causes a decrease in pressure gradient across the mitral valve and decreases in pulmonary blood pressure. It also partially improves lung function. However, some of the pulmonary changes secondary to MS may be permanent.[14-17] Therefore, FEV1, FVC, and VC may show increased values in the short and long-term after PTMC,[18] but limitation of flow especially at flows near to RV may persist long-term.[19] Other studies showed increased MVV, VC, FEF50%, FEF75% and no changes in FEV1/FVC.[20] This study reevaluates the short-term effect of PTMC on dynamic lung volumes.

Methods

Patients with moderate to severe MS who were candidates for percutaneous transvenous mitral commissurotomy (PTMC) and had good mitral valve morphology with an echocardiography score less than 11, no coronary artery disease or left atrial clot were included in this study. All the patients with unsuccessful PTMC (less than 25% change in mitral valve area, or final mitral valve area less than 1.5 cm^2), echo score equal to or more than 11, severe mitral regurgitation (MR), prominent CHF, history of previous lung disease and smoking were excluded. From 2004 to 2005, 51 patients with MS and the above-mentioned criteria underwent spirometery and PTMC. 25 patients were excluded because of presence of coronary artery disease, development of severe mitral regurgitation, and mitral valve area changes less than 25% with PTMC. 26 patients fulfilled the criteria and underwent second spirometery with ATS criteria within 48-72 hours after PTMC. All the demographic values including weight, height, age, sex, and height of region were measured. Total, percent predicted, mean, standard deviation, maximum and minimum of values were measured and recorded. Mean values of measured flows and volumes were compared with paired t test with SPSS software. Correlation of mitral valve area with lung volume and flows were studied statistically with linear regression.

Results

Findings before PTMC

From 26 patients who fulfilled the criteria of our study, 12 were female and 14 were male. Mean age was 38.38 years (max 74, min 15 years); mean values of mitral valve area was 0.88 cm^2, SD=0.19 (max 1.20 cm^2 , min 0.5 cm^2); mean echo score was 7.5 SD=1.27 (max 10, min 5).

Mean value of FEV1 before PTMC was 1.97 liter, SD=0.63 (max 3.29, min 0.98 liter); FVC was 2.38 liter, SD=0.72 (max 3.99, min 1.19 liter) and SVC was 2.59 liter SD=0.77 (max 3.99, min 1.33 liter). Mean value of FEV1 / FVC was 83.38%, SD = 15.68 (max

100, min 38.99 percent). Mean value of peak expiratory flow rate (PEFR) was 5 l/s, SD=1.8 (max 9.30, min 1.75). These values for forced expiratory flow at 75% of VC were 4.49 l/s, SD=1.85 (max 8.72, min 1.67); for FEF 50% they were 2.93, SD=1.33 (max 5.70, min 0.92) and for FEF 25% they were 1.50, SD=1.01 (max 4.45, min 0.43). Mean value of maximum mid expiratory flow rate (MMFR) were 2.99, SD=1.25 (max 5.83, min 1.05). Mean value for maximum voluntary ventilation were 60.98 lit/min, SD= 24.25 (max 123, min 26.6 lit/sec).

Findings after PTMC

26 patients were studied, 12 female and 14 male, mean value of mitral valve area was 1.46 cm^2, SD=0.18 (max 1.80 cm^2 , min 1.20 cm^2). Mean value of FEV1 after PTMC was 2.22 liter, SD=0.62 (max 3.37, min 0.96 liter), FVC was 2.60 liter, SD=0.69 (max 3.3.88, min 1.30 liter) and SVC was 2.69 liter SD=0.75 (max 4.14, min 1.31 liter). Mean values of FEV1/FVC was 86.28%, SD=10.02 (max 100, min 63.80 percent).

Mean value of peak expiratory flow rate (PEFR) was 4.73 liter/second, SD=1.9 (max 8.91, min 1.57). These values for forced expiratory flow at 75% of VC were 4.93 l/s, SD=1.57 (max 7.30, min 1.44) for FEF 50% were 3.87, SD=1.50 (max=6.90, min 0.82) and for FEF 25% were 2.48, SD=1.1.67 (max 5.40, min 0.38). Mean value of maximum mid expiratory flow rate (MMFR) were 3.70, SD= 1.44 (max 6.30 and min 0.96).

Mean value for maximum voluntary ventilation were 60.98 liter/minute, SD= 24.25 (max 123, min 26.6 liter/second).

In this study mean mitral valve area changed from 0.88 cm^2 before PTMC to 1.46 cm^2 after PTMC. This change was significant (P<0.000). Mean value of FEV1 and FVC was 1.97 L and 2.38, they increased to 2.22 L and 2.60 and these changes were significant (p<0.003 and p<0.005, respectively). The values for SVC and FVC/FEV1 were not significant (Fig. 1 and Table 1).

Mean values of mid flows were significant. P values for the FEF50, FEF25 and FEF25-75 were less than 0.004, 0.003 and 0.01. But PEFR and FEF 75% were not significant. (Table I).

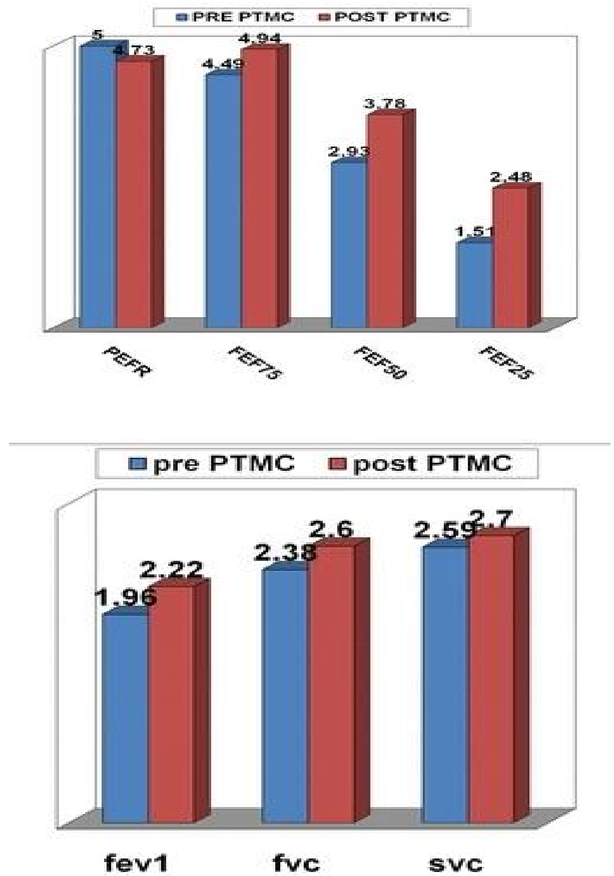

Fig. 1. Mean value of FEV1, FVC, SVC, FEV1/FVC, PEFR, FEF75%, FEF50%, FEF25%, FEF25-75 AND MV area before and after PTMC

Table I. Mean Values of PEFR, FEF75%, FEF50% and FEF25% (left) and FEV1, FVC, and SVC (right) in 26 studied patients before and after PTMC

variable	FEV1	FVC	SVC	FEV1/FVC	PEFR	FEF75	FEF50	FEF25	FEF25-75	MV AREA
Mean before PTMC	1.97	2.38	2.59	83.36	5	4.49	2.93	1.50	2.99	0.88
Mean after PTMC	2.22	2.60	2.69	86.28	4.73	4.93	3.78	2.48	3.70	1.46
Difference	0.25	0.22	0.1	2.92	-0.27	0.44	0.85	0.98	0.71	0.14
P value	0.003	0.005	NS	NS	NS	NS	0.004	0.003	0.01	0.000

Discussion

The design of this study is very similar to the studies by Yoshioka and Joan and it is possible to compare most of our data. They studied 24 MS patients before and after PTMC at short (24-48hrs) and long-term (6 months later). They showed improvement of PEFR and FEF75% and no changes in flow of 50 and 25% and FEF25-75 and suggested that it may be due to irreversible changes in the small airways. In another study by Joan and coworkers[19] on 23 patients, decrease in flows near to RV was shown and they concluded that these findings are related to irreversible changes of the peribronchiolar wall. Yoshoki and coworkers[20] studied 25 patients with MS and showed an increase at FEF 50% and 75%. In this study FEF 75% and PEFR had no changes but FEF 25% and 50% had significant improvements. It suggests that resolution of peribronchial cuffing and pulmonary congestion may cause an increase in conductance and a decrease in the resistance of the small airways. Improvement of obstruction of the small airways with the treatment of congestive heart failure in another study, reinforce this hypothesis that the resolution of peribronchiolar cuffing may cause improvement in the mid flows. The mean age of our patients was 38 and male to female ratio was 3/12. It is similar to the study of H.Y. Lime and opposed to other studies. The most probable explanation for this difference is social differences and sample size. In this country men are more active and do more physical work than women and they may become symptomatic sooner.

In this study and other present studies, most patients had a restrictive pattern on PFT. The most probable explanation for this pattern are pulmonary congestion and interstitial edema in the short term and interstitial fibrosis and cardiac enlargement in the long-term. Less improvement of SVC may be due to technical error and technical dependency of SVC in comparison with FVC and FEV_1. Mean value of FEV_1/FVC had no changes in this study and other acceptable studies. It is reported that there is a correlation between lung circulatory volume and lung volume and flow changes in different studies [3,18-20] and it is also reported that more severe stenosis of mitral valve area may cause more severe pulmonary congestion.[1,3] In this study, correlation between lung volumes and flows with mitral valve area were weak, both before and after PTMC. But in another study by Rhodes et al.[8] there was a correlation between lung volumes and mitral valve area and hemodynamic data, but no correlation with FEV/FVC percent. This difference may be explained by the small sample size and the presence of confounding variables in our study.

Conclusion

In this study, short term mean value of FEV_1, FVC, $FEF_{50\%}$, $FEF_{25\%}$ and $FEF_{25-75\%}$ increased significantly after successful balloon mitral valvotomy, but SVC, $FEF_{75\%}$ and PEFR had no significant improvement. This may suggest improvement of the small airways function due to a decrease in lung congestion.

Conflict of Interest

No conflicts of interest have been claimed by the authors.

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