A Pre-post Study on Hemodynamic Differences Following Percutaneous Mitral Commissurotomy in Mitral Stenosis Patients with Atrial Fibrillation and Sinus Rhythm

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Abstract

Background: The development of atrial fibrillation (AF) is a common condition in mitral stenosis (MS), and the monitoring of hemodynamic parameters in patients after a successful percutaneous mitral commissurotomy (PMC) is of great importance for the prediction of late events.

Objective: This study aimed to investigate the pre-and post-PMC hemodynamic data between AF and sinus rhythm (SR) patients.

Methods: This was a retrospective study consisting of 98 patients who underwent PMC at Suratthani Hospital between January 2013 and December 2019. Patient characteristics, echocardiogram, and hemodynamic data before and after PMC were collected, and a student t-test was applied to compare the differences between AF and SR groups.

Results: Of 98 patients, the majority of patients were in the AF category (75.5%). The age of the patients with AF was significantly higher than SR in the study (54.66±11.80 vs 48.79±13.26 years; p=0.04). Pre-PMC hemodynamic data showed that the AF group had significantly larger LA size (5.49±0.80 vs 4.95±0.63 cm; p<0.01) and higher LA pressure (25.56±8.26 vs 20.0±8.52 mmHg; p<0.01) than the SR group. After PMC, LA size was also significantly higher in the patients with AF than SR (5.16±0.73 vs 4.54±0.81 cm; p<0.01). Post-PMC LAP between the groups had a similar trend (18.76±7.17 vs 12.91±5.43 mmHg; p<0.01). However, the pre-and post-PMC readings for MVA, mean pulmonary pressure and transmitral pressure gradients were statistically not different between AF and SR groups.

Conclusion: The patients with MS and AF were older and they had considerably larger LA size and higher LA pressure than patients with MS and SR. The SR group had lower but insignificantly different pulmonary artery systolic pressure than the AF group in the study.

Keywords: Atrial Fibrillation, Hemodynamic, Percutaneous Mitral Commissurotomy, Sinus Rhythm

Introduction

Rheumatic mitral stenosis (MS) is an acquired progressive form of valvular heart disease, characterized by the diffused thickening of mitral valve leaflets, the fusion of commissures, and the shortening and fusion of chordae tendinae. The disease can cause an acute embolic ischemic stroke if untreated in time (1). Although medical treatment can release symptoms, it does not affect the obstruction of blood flow. A non-surgical means to treat MS named percutaneous mitral commissurotomy (PMC) was introduced in 1984 by Inoue (2). Since then the technique has proved to be an effective method for providing favorable short and long-term outcomes (3, 4).

The development of atrial fibrillation (AF) is common in patients with MS (5, 6) and it is associated with hemodynamic changes, and clinical deterioration including predisposition to systemic and pulmonary thromboembolism (7, 8). Published literature suggests that AF in MS is an essential predictor of unfavorable clinical outcomes compared to sinus rhythm (SR) (9). The protection of the SR in patients with MS is very important to reduce the risk and the reduction of symptoms. However, we have witnessed in our catheterization laboratory that the patients with SR have higher mean gradient pressure between the left atrium and ventricular as well as a higher pulmonary artery pressure than AF patients.

In this regard, a study was designed to investigate the pre and post-PMC hemodynamic differences in the patients of MS with AF and SR. This monitoring of hemodynamic parameters in a wide range of patients is of great importance for the identification of prognostic factors. We hypothesized that a combination of demographic and echocardiographic findings could aid to predict the incidence of AF.

Methods

Study population

This was a retrospective study conducted at Suratthani Hospital. A total of 114 patients with severe MS underwent PMC in the hospital between January 2013 and December 2019. Out of these, 98 (85.9%) patients with successful PMC treatment were enrolled in the study. The patients who had severe MS but were treated successfully by PMC at Suratthani Hospital were included in the study. On the other hand, patients with severe mitral regurgitation requiring mitral valve surgery were excluded. The details of patient enrollment and exclusion are outlined in Figure 1.

Study protocol

Patient characteristics, echocardiogram findings, and hemodynamic data before and after the procedure were collected from the

hospital system and medical records. The patients were divided into AF (n=74) and sinus rhythm (n=24) according to the baseline electrocardiogram. SR was categorized as rhythm without paroxysmal AF at the time of PMC. Permanent AF was defined as AF that has been agreed upon by both the patient and physician and for which no further attempts at reconditioning/maintaining SR were made. A transthoracic echocardiogram was performed before and one day after undergoing PMC to measure pulmonary artery systolic pressure (PASP), mitral valve area (MVA), left atrium (LA) size, mean transmitral pressure gradient (TMPG), and other parameters. LA diameter was estimated as the maximum distance between the trailing edge of the LA aortic wall and the leading edge of the LA posterior wall at the end of ventricular systole in the parasternal long-axis view.

PMC was performed using an Inoue balloon that was placed in antegrade using a trans-septal catheterization. The procedure was considered successful when no acute mitral valve replacement was required and resulted in MVA greater than 1.5 mm^2 or an MVA increased greater than 50%. The study complied with the Declaration of Helsinki and was approved by the Ethics Committee of the Suratthani Hospital (27/2563).

Statistical analysis

Continuous data were described in terms of mean and standard deviation (SD), and dichotomous variables as a percentage. The comparison of continuous variables was done by paired and two-sample t-tests. The Chi-squared or Fisher's exact test was applied for dichotomous variables. STATA version 10.1 was used to compile and analyze data when a p-value of less than 0.05 was classified as statistically significant.

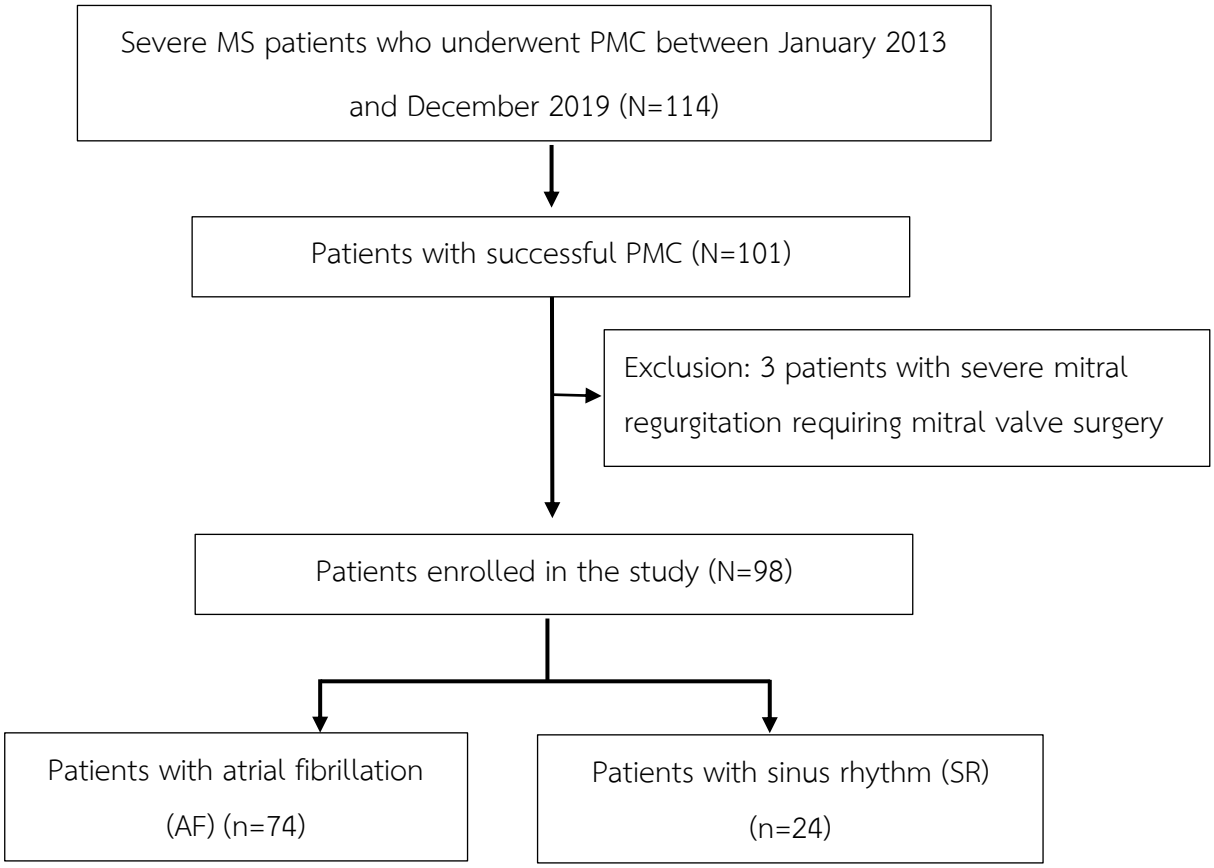

Figure 1: Flow diagram showing patient's enrollment in the study

Results

Out of 98 enrolled patients, the majority were in the AF group (75.5%). The mean age of the patients with AF (54.66±11.80 years) was significantly higher (p=0.04) than SR (48.79±13.26 years). Female predominance was present in both groups. No statistical difference was observed in the terms of diabetes mellitus, hypertension, dyslipidemia, and others as shown in Table 1.

Table 1 Baseline characteristics of the patients (n=98)

Variable	Sinus rhythm N (%) (N =24)	Atrial fibrillation N (%) (N=74)	P-value
Male	3 (12.50)	15 (20.27)	0.39
Age (mean±SD)	48.79±13.26	54.66±11.80	0.04*
Diabetes mellitus	1 (4.17)	10 (13.51)	0.20
Hypertension	4 (16.67)	15 (20.27)	0.69
Dyslipidemia	4 (16.67)	19 (25.68)	0.36
Previous CVA	2 (8.33)	13 (17.57)	0.27
Previous PMC	0 (0.00)	4 (5.41)	0.24

*p-value < 0.05

CVA: cerebrovascular accident; PMC: percutaneous mitral commissurotomy

Hemodynamic measurements of pre- and post-PMC in both AF and SR groups are shown in Table 2. The hemodynamic data showed that the AF group had significantly larger LA size (5.49±0.80 vs 4.95±0.63 cm; p<0.01) and higher LA pressure (25.56±8.26 vs 20.0±8.52 mmHg; p<0.01) than the SR group. Likewise, the AF group had insignificantly higher PASP and mean pulmonary pressure (MPAP) than the SR group in the study. No statistical changes were observed for MVA and transmitral pressure gradients between the groups. After PMC, the AF patients had significantly larger LA size than the SR patients (5.16±0.73 vs 4.54±0.81 cm; p<0.01) in the study. LAP was also significantly higher in AF patients after PMC compared to SR patients (18.76±7.17 vs 12.91±5.43 mmHg; p<0.01). MPAP in patients with AF was higher and near the significance level compared to the SR patients. Of importance, the change in pre-and post-PMC hemodynamic data between the AF and SR patients was not significant (Table 3). Three cases of congestive heart failure were found to have occurred as the complications with PMC procedure in the study.

Table 2 Hemodynamic measurements before and after PMC between AF and SR

Hemodynamic parameter	Pre-PMC		P-value	Post-PMC		P-value
	SR	AF		SR	AF	
MVA (cm^2)	1.05±0.27	1.00±0.27	0.43	1.65 ±0.47	1.45±0.43	0.06
LA size (cm)	4.95 ± 0.63	5.49 ±0.80	<0.01	4.54±0.81	5.16±0.73	<0.01
PASP (mmHg)	52.73±15.90	57.85±20.80	0.27	41.45±9.90	47.79±16.92	0.08
LAP (mmHg)	20.0±8.52	25.56±8.26	<0.01	12.91±5.43	18.76±7.17	<0.01
MPAP (mmHg)	35.39±11.00	39.33±13.63	0.20	26.66± 5.65	31.36±11.13	0.055
TMPG (mmHg)	11.82 ±5.07	10.32±3.56	0.11	6.58±3.23	6.37±2.73	0.75

MVA: mitral valve area; LA: left atrium; PASP: pulmonary artery systolic pressure: LAP: left atrial pressure; MPAP: mean pulmonary pressure; TMPG: transmitral pressure gradients

Table 3 Difference in hemodynamic data before and after PMC between AF and SR

Hemodynamic factors	AF	SR	P-value
MVA (cm^2)	0.59±0.54	0.46±0.42	0.21
LA size (cm)	0.41±0.57	0.39±0.69	0.90
PASP (mmHg)	12.1±12.26	10.94±13.09	0.72
LAP (mmHg)	6.82±7.67	6.54±6.16	0.86
MPAP (mmHg)	9.66±9.55	8.65±9.36	0.66
TMPG (mmHg)	5.31±4.86	4.02±2.89	0.12

MVA: mitral valve area; LA: left atrium; PASP: pulmonary artery systolic pressure; LAP: left atrial pressure: MPAP: mean pulmonary pressure; TMPG: transmitral pressure gradients

Discussion

We aimed to investigate the differences in hemodynamic data in MS patients with AF and SR before and after undergoing PMC. Protection of the sinus rhythm in patients with MS is very important to reduce the risks such as cerebral embolism, and maintenance of cardiac output and exercise capacity. Endocardial damage, hypercoagulability, and blood retention in the left atrium are behind the thrombus formation in AF that results in strokes. When the left atrium is unable to contract efficiently it causes atrial tension and enlargement, thereby, enhancing thrombus formation. However, the maintenance of SR improves symptoms, exercise capacity, and quality of life. AF affects both immediate and

long-term outcomes after PMC. Therefore, the findings from studies of our kind are vital. We revealed that advanced age was associated with AF in patients with MS.

The percentage of AF patients was high (75.5%) in the study, which is more than earlier reports mentioning that about 40% of MS patients develop AF (6). Moreover, the age of the patients with AF was significantly higher (p=0.04) than patients with SR in the study. This corroborates with previously reported studies (10, 11). Also, the age of the patients in the study was similar to the earlier study (55±13.9 years) based on the Thai National database (12). The exact pathophysiology behind aging and the rise in the odds of AF development remain unknown. In general, people with an increase in age get the atrial myocardium exposed to risk factors for a longer period. Interestingly, the causative factors for AF in the elderly are expected to differ from younger patients (13). Next, the incidence of AF has been reported to be higher in men (14, 15) but we found a higher number of female patients in the study. It is unknown whether this difference is due to sex itself or other factors.

MVA was increased in both groups after PMC. On the other hand, LA size was reduced in patients with AF and SR before and after the intervention. It is mentioned that the greater MVA and smaller LA size are the main predictors of restoration and maintenance of SR (16). Of importance, the change in MVA and LA size, and other parameters in both groups pre and post-PMC was not significant in the study.

In general, AF can lead to a fall in cardiac output causing powerful LA contraction and thereby, an enlargement of the left atrium including the increase in its pressure. The LA size of the patients in pre- and post-intervention conditions was larger in the AF group compared to SR, implying a relationship between rhythm and left atrial dimension. Likewise, LA pressure was significantly decreased in both AF and SR patients compared to before and after undergoing PMC. LA pressure is reported to be higher in patients with persistent AF (17).

The earlier published report has also revealed larger LA and lower Pre-PMC pulmonary artery (PA) pressure in Thai patients with MS and AF than MS and SR. More favorable PA and LA pressure reduction were recorded in patients with SR than in AF (18). Another study has reported that long-term adverse findings were common in Thai patients with rheumatic MS in SR and correlated with left atrial dimension and left ventricular end-systolic dimension (19). Of importance, a recently published study has highlighted that PMC is an effective and safe treatment in Thai rheumatic MS patients with moderate mitral regurgitation (20).

We are aware of the limitations of the study. It is a retrospective study of a limited sample size from one institution. The

inclusion of more samples including the evaluation of long-term clinical outcomes would increase the importance of such research. Nevertheless, our finding provides preliminary data for the identification of prognostic factors in MS patients with AF and SR who underwent PMC.

Conclusion

The study reveals that the MS patients with AF were having advanced age. Initially, the patients with AF had larger LA size, higher PASP, and lower transmitral pressure gradient than patients with SR. After successful PMC, the patients with SR had increased and nearly significant MVA compared to patients in the AF group.

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