Percutaneous Transvenous Mitral Commissurotomy: Hemodynamic and Initial Outcome Differences Between Atrial Fibrillation and Sinus Rhythm in Rheumatic Mitral Stenosis Patients

SUPHOT SRIMAHACHOTA, M.D.*,
MALLIKA WANNAKRAIROJ, M.D.*,
SOMKAIT SANGWATTANAROJ, M.D.*,
DAUNCHAI CHAYANONT, M.D.*
SMONPORN BOONYARATAVEJ, M.D.*,
WASAN UDAYACHALERM, M.D.*,
PUNGCHAI NGARMUKOS, M.D.*

Abstract

Background : Atrial fibrillation (AF) occurs frequently in severe rheumatic mitral stenosis (MS) and has been reported to be a predictor of poor outcome after percutaneous transvenous mitral commissurotomy (PTMC). Nevertheless, according to observations in our catheterization laboratory, patients with sinus rhythm (SR) seem to have a higher pulmonary artery pressure than AF.

Purpose : To determine 1) the hemodynamic differences between MS patients with AF and SR before and after PTMC and 2) the success rate and difference in outcome between both groups.

Method : A total of 145 patients who had undergone PTMC with the Inoue balloon technique in King Chulalongkorn Memorial Hospital between 1993 and 1997 were enrolled. The data were presented as mean ± SD. Student *t*-test was used to compare the difference in hemodynamic and outcome between the AF and SR groups.

Results : Fifty-six patients (38.6%) were in the AF group. The AF patients were older (42.0 ± 11.3 *vs* 32.4 ± 8.7 yr., $p < 0.0001$), had a larger left atrium (49.2 ± 6.1 *vs* 45.3 ± 4.9 mm, $p < 0.001$) and a higher valvular calcification score (1.8 ± 0.6 *vs* 1.5 ± 0.6, $p = 0.02$) than the SR group. There was no significant difference between baseline heart rate and overall MV score index. The hemodynamic data showed that the SR group had higher systolic (59.9 ± 26.0 *vs* 47.4 ± 16.8 mmHg, $p < 0.05$), diastolic (28.1 ± 12.8 *vs* 22.7 ± 9.2 mm Hg, $p < 0.05$) and mean (40.1 ± 17.1 *vs* 32.7 ± 11.8 mmHg, $p < 0.05$) pulmonary artery (PA) pressure than the AF group. After successful PTMC, the SR group exhibited a more favorable change in all PA pressures and the transmitral valvular gradient (10.0 ± 6.5 *vs* 6.7 ± 6.5 mmHg, $p < 0.01$) than the AF group. Procedural success rates were 98 per cent in the AF and 96 per cent in the SR group (p = ns). Transthoracic colour-flow echocardiographic imaging detected atrial septal defects in 18.2 per cent and 7.5 per cent ($p = 0.08$) of the AF and SR groups, respectively. There was no systemic embolization, peri-procedural death or emergency surgery in both groups.

Conclusion : Patients with MS and AF were older, had a larger LA and lower pre-PTMC PA pressure than the patients who had MS and SR. In addition, patients with SR had a more favourable PA and LA pressure reduction than patients with AF.

Key word : Percutaneous Transvenous Mitral Commissurotomy, Atrial Fibrillation, Sinus Rhythm

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* Cardiac Center and Division of Cardiovascular Diseases, Department of Medicine, King Chulalongkorn Memorial Hospital, Bangkok 10330, Thailand.

In 1984, Inoue[1] introduced a technique of percutaneous transvenous mitral commissurotomy (PTMC) with a new balloon for the treatment of severe mitral stenosis (MS). This technique was developed with the aim of achieving an equivalent effect for mitral commissurotomy without thoracotomy by using the expansible force of the balloon. Many reports have shown the same excellent immediate and long-term results[2-8] as those produced by closed and open mitral commissurotomy[9-11] in terms of increasing the mitral valve (MV) area and improving the New York Heart Association (NYHA) functional class.

About 20–60 per cent[3-6] of MS patients had atrial fibrillation (AF). It has been reported that AF was a predictor of poorer outcome after PTMC compared with sinus rhythm (RS)[3,4,7]. However, we have noticed in our catheterization laboratory that MS with SR patients seem to have higher pulmonary artery pressure which may indicate a poorer outcome than AF patients. Therefore, this study was conducted to compare the hemodynamic differences and outcome in MS patients having AF with those having SR after PTMC.

PATIENTS AND METHOD

Patient population

All rheumatic MS patients with either AF or SR who had undergone PTMC using the Inoue balloon technique at King Chulalongkorn Memorial Hospital between 1993 and 1997 were enrolled. Patients who had moderate to severe mitral regurgitation (MR), or left atrial (LA) thrombus outside the LA appendage were excluded. Patients' history, echocardiogram findings, hemodynamic parameters before and after the procedure and complications were recorded prospectively after completing the procedure in both the AF and SR groups. Transthoracic echocardiography was performed to measure MV area, LA size, grading of MR, atrial septal defect (ASD) and other parameters one day after PTMC.

Percutaneous transvenous mitral commissurotomy

Transthoracic and transesophageal echocardiographies were performed before the procedure. The mitral valve score was classified based on the echocardiographic morphology[13] and the MV area was measured. Standard right and left cardiac catheterization and left ventricular (LV) angiography were performed in each case except for pregnant women to avoid radiation exposure. Atrial transseptal puncture was performed under fluoroscopy except for one case with a thrombus in the LA appendage, where guided transesophageal echocardiography was applied. Inoue balloon catheter (Toray Industries, Japan) was used for mitral valve dilatation. After successful balloon dilatation, hemodynamic and oxygen saturation were measured. LV angiography was repeated to evaluate the degree of MV regurgitation.

Definition of success

A successful case was defined as a patient who either showed a reduction of the transmitral valve gradients by more than 50 per cent or a resi-

Table 1. Baseline characteristics of mitral stenosis patients.

	AF	SR	P value
No. of cases (%)	56 (38.6%)	89 (61.4%)	
Age (yr.)	42.0 ± 11.3	32.4 ± 8.7	< 0.0001
Female (%)	73.2	85.4	NS
Heart rate (bpm)	81 ± 18	81 ± 17	NS
Left atrial size (mm)	49.2 ± 6.1	45.3 ± 4.9	< 0.001
MVA (cm^2)	0.8 ± 0.2	0.8 ± 0.2	NS
Mitral valve score	7.8 ± 1.5	7.3 ± 1.6	NS
: Valvular thickening	2.1 ± 0.5	2.1 ± 0.5	NS
: Subvalvular thickening	2.1 ± 0.6	2.0 ± 0.6	NS
: Valvular calcification	1.8 ± 0.6	1.5 ± 0.6	0.02
: Leaflet mobility	1.9 ± 0.5	1.8 ± 0.5	NS
NYHA FC	2.6 ± 0.5	2.5 ± 0.5	NS

NYHA FC-New York Heart Association Functional Classification

dual mean gradient after balloon dilatation below 5 mmHg without adverse events such as severe mitral regurgitation equal or above graded 3+ according to Seller's classification[14] using left ventriculography, emergency surgery or procedure-related death. If left ventriculography couldn't be performed, echocardiography was used to determine severity of mitral regurgitation.

Statistical analysis

The continuous variables are expressed as mean ± SD. For the analysis of continuous data, two-tailed student *t*-test was used to assess the differences between both groups. The nominal variables were expressed as counts and percentages. Statistical significance was expressed by the chi-square test. All tests were considered statistically significant when the P value was below 0.05.

RESULTS

There were 145 MS patients who had undergone PTMC with the Inoue balloon technique in King Chulalongkorn Memorial Hospital between January 1993 and December 1997. Fifty six patients (38.6%) with AF had a higher mean age (42.0 ± 11.3 *vs* 32.4 ± 8.7 yr., p<0.0001) and a larger LA (49.2 ± 6.1 *vs* 45.3 ± 4.9 mm, p=0.0003) than the SR group (Table 1). There were no statistically significances as to gender, heart rate, MV area and New York Heart Association functional class. Regarding the MV score index, the AF group had a higher valvular calcification score than the SR group (1.8 ± 0.6 *vs* 1.5 ± 0.6, p = 0.0189). Table 2 shows the hemodynamic data pre- and post- PTMC in both the AF and SR groups. The SR group had higher systolic, diastolic and mean pulmonary artery (PA) pressure than the AF group before PTMC and after PTMC the systolic PA pressure was still higher. No differences in LA pressure, transmitral valvular pressure gradient, heart rate and MV area before and after PTMC were observed. As to the pre- and post- PTMC hemodynamic differences (Table 3), the SR group exhibited more favorable changes in systolic PA, diastolic PA, mean PA, LA and transmitral valvular pressure gradient, respectively, after PTMC than the AF group. Despite the similarity in balloon size, fluoroscopy and procedure time and the overall success rate (Table 4), the AF group developed atrium septal defect (ASD) detected by echocardiography more frequently than the SR group but this was not statistically significant (18.2% *vs* 7.5, p = ns). Only 3.8 per cent of the AF group and 4.7 per cent of the SR group had a significant oxygen step-up at the LA level. The size of ASD in most cases detected by echocardiography was less than 7 mm. Three cases in the SR group failed to puncture the interatrial septum, and one of these had hemopericardium and pericardiocentesis was required. One case in the SR group couldn't pass the balloon across MV. There was only one case in the AF group with severe MR (grade 3+) after balloon dilatation. None of the patients succumbed to procedural death or was in need of emergency surgery.

DISCUSSION

AF in rheumatic MS has been reported to be a predictor of poor outcome in many studies[3,

Table 2. Hemodynamic pre- and post- percutaneous transvenous mitral commissurotomy between atrial fibrillation (AF) and sinus rhythm (SR) patients.

	Pre-PTMC		Post-PTMC	
	AF	SR	AF	SR
PAS (mmHg)	47.4 ± 16.8	59.9 ± 26.0*	37.2 ± 11.2	42.6 ± 14.5γ
PAD (mmHg)	22.7 ± 9.2	28.1 ± 12.8*	16.7 ± 6.1	17.6 ± 7.5
PAM (mmHg)	32.7 ± 11.8	40.1 ± 17.1*	25.8 ± 7.4	27.8 ± 10.0
LA pressure (mmHg)	20.6 ± 7.9	22.5 ± 8.6	13.9 ± 6.0	12.6 ± 5.0
LA/LV gradient (mmHg)	11.3 ± 5.5	13.5 ± 8.0	3.6 ± 2.6	2.9 ± 2.4
Heart rate (bpm)	81 ± 18.0	81 ± 17.0	76 ± 16.7	77 ± 15.5
LA size (mm)	49.2 ± 6.1	45.3 ± 4.9β	45.4 ± 6.3	40.5 ± 4.7β
MVA (cm^2)	0.8 ± 0.2	0.8 ± 0.2	1.3 ± 0.3	1.4 ± 0.3
Grading of MR	0.5 ± 0.5	0.4 ± 0.5	0.8 ± 0.6	0.6 ± 0.7

γ $p < 0.05$, * $p < 0.01$, β $p < 0.001$
PAS-systolic pulmonary artery pressure; PAD-diastolic pulmonary artery pressure;
PAM-mean pulmonary artery pressure; LA-left atrium; LV-left ventricle;
MVA-mitral valvular area; MR-mitral regurgitation
LA/LV gradient = mean diastolic pressure gradient across mitral valve

Table 3. Hemodynamic difference pre- and post- percutaneous transvenous mitral commissurotomy (PTMC) between atrial fibrillation (AF) and sinus rhythm (SR).

	AF	SR	P value
Δ PAS (mmHg)	10.1 ± 13.0	17.1 ± 17.3	0.01
Δ PAD (mmHg)	6.0 ± 7.8	10.5 ± 9.5	<0.01
Δ PAM (mmHg)	6.9 ± 8.5	12.3 ± 11.3	<0.01
Δ LA (mmHg)	6.7 ± 6.5	10.0 ± 6.5	<0.01
Δ LA/LV gradient (mmHg)	7.7 ± 4.9	10.6 ± 7.1	0.01
Δ MVA (cm^2)	0.5 ± 0.3	0.6 ± 0.3	NS

Δ = Difference value between pre and post
PAS-systolic pulmonary artery pressure; PAD-diastolic pulmonary artery pressure;
PAM-mean pulmonary artery pressure; LA-left atrium; LV-left ventricle;
MVA-mitral valvular area; D-different value between pre and post PTMC

4,7). However, these reports didn't directly compare hemodynamic and outcome differences between patients with AF and SR. Acar J[14] reported that MS patients with AF were older, had a larger LA and a higher percentage of mitral valve calcification but a lower transmitral pressure gradient than SR patients. There was no significant difference in mean PA and LA pressure between both groups. When compared with our data, the AF group also had a higher age, a larger LA and a higher score of calcification but no significant difference in the transmitral pressure gradient. AF usually develops in the late stage after LA dilation then patients in this group are older and more calcified mitral valve. Systolic, diastolic and mean PA pressures were higher in the SR group. After successful balloon dilatation, the reduction of PA, LA pressure and transmitral pressure gradient, respectively, in the SR group was significantly more favorable than in the AF group.

Why was the PA pressure in the SR group higher than in the AF group? When the patient had severe MS with SR, the LA pressure increased. The powerful LA contraction across the narrowing valve orifice increased the pressure in the pulmonary veins and arteries, causing pulmonary hypertension (Fig. 1). When AF developed, the PA pressure decreased due to a decline in LA contraction.

Table 4. Result of percutaneous transvenous mitral commissurotomy in atrial fibrillation (AF) and sinus rhythm (SR) patients.

	AF	SR	P value
No. of cases	56	89	
Success rate (%)	98.2	95.5	NS
Fluoroscopy time (min)	22.2 ± 9.6	24.9 ± 12.5	NS
Procedure time (min)	88.3 ± 24.0	87.4 ± 24.8	NS
Maximal balloon size (mm)	25.2 ± 1.3	25.3 ± 1.2	NS
Failure to transseptal puncture	0	3 (3.3%)	NS
ASD (echocardiogram) (%)	18.2	7.5	NS
ASD (catherization*) (%)	3.8	4.7	NS
Severe MR	1 (1.8%)	0	NS
Cardiac tamponade	0	1 (1.1%)	NS
Emergency surgery	0	0	NS
Death (%)	0	0	NS

* : Step-up of oxygen saturation in right atrium above 7%
ASD-atrial septal defect; MR-mitral regurgitation;

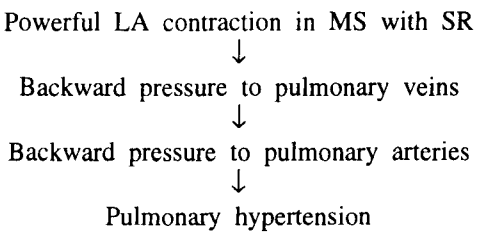

Fig. 1. Probable mechanisms accounting for the increase in high pulmonary artery pressure in patients with mitral stenosis who had sinus rhythm.

The success rate of PTMC was high and complications occurred in only a few cases. That may be why we could not detect any significant difference in our patients. The number of patients was too small to allow for the detection of the low events rate. However, ASD post- PTMC detected by echocardiography had a tendency to occur more frequently in AF the group. The incidence of ASD post- PTMC has varied between studies[2,4,5,8,15-17] depending on the methods and timing of evaluation. Approximately 1–13 per cent of the patients developed ASD detected by oximetry[2,4,17]. Arora [8] reported the incidence of ASD, detected by transesophageal echocardiography immediately after PTMC, in 92 per cent but only 4 per cent persisted by the 6-month follow-up. The mean closure time was 4.6 ± 2.2 weeks[16]. In our study, severe MR occurred in only one patient (1.8%) in the AF group but the patient didn't have any symptom of acute severe MR. One in the SR group had cardiac tamponade during transseptal puncture. Incidences of severe MR and cardiac tamponade were reported in 1.9-5.2 per cent and 0.2-1.9 per cent[2,4,5,17], respectively. In our study, no evidence of systemic embolism was observed because transesophageal echocardiography was performed in all patients to detect LA thrombus before PTMC. Only one case in the AF group demonstrated a thrombus in the LA appendage and PTMC was successfully performed under transesophageal echocardiography without evidence of systemic embolism.

Study limitation

The number of cases in this study was small and some baseline characteristics were also different. However, these baseline differences resulted from the nature of the group itself and didn't effect outcomes much. ASD detected from

echocardiography is very sensitive and may not effect hemodynamic as detected in the catheterization laboratory using step-up of oxygen saturation. Follow-up data should be conducted to determine the long-term outcomes.

SUMMARY

MS patients with AF were older, had a larger LA size and lower PA pressure before PTMC than the patients with SR. Patients with SR showed a more favourable PA and LA pressure reduction than patients with AF post- PTMC. There was no difference in the initial outcome between both groups.

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การเปลี่ยนแปลงทางฮีโมดัยนามิคส์และผลการรักษาระยะแรกในผู้ป่วยลิ้นไมทรัลตีบจากโรคหัวใจรูมาติก ที่มีและไม่มี atrial fibrillation ภายหลังการทำบอลลูนขยายลิ้นหัวใจ

สุพจน์ ศรีมหาโชตะ, พ.บ., มัลลิกา วรรณไกรโรจน์, พ.บ.*, สมนพร บุณยะรัตเวช, พ.บ.*, วสันต์ อุทัยเฉลิม, พ.บ.*, สมเกียรติ แสงวัฒนาโรจน์, พ.บ.*, พึงใจ งามอุโฆษ, พ.บ.*, เดือนฉาย ชยานนท์, พ.บ.**

ภูมิหลัง : ภาวะหัวใจเต้นผิดปกติแบบแผ่วระรัวจากห้องบน (atrial fibrillation) พบได้บ่อยในผู้ป่วยที่มีการตีบแคบชนิดรุนแรงของลิ้นไมทรัลที่เกิดจากโรคหัวใจรูมาติก และมีรายงานว่าเป็นตัวบ่งชี้ที่ไม่ดีในการทำการขยายลิ้นหัวใจด้วยบอลลูน อย่างไรก็ตาม จากการสังเกตในห้องสวนหัวใจของเรา พบว่า ผู้ป่วยกลุ่มที่มีการเต้นของหัวใจปกติมักจะมีระดับความดันของเส้นเลือดแดงที่ปอดสูงกว่ากลุ่มที่มีหัวใจเต้นผิดปกติแบบแผ่วระรัวจากห้องบน

วัตถุประสงค์ : เพื่อศึกษา 1) การเปลี่ยนแปลง hemodynamic ของผู้ป่วยที่มีการเต้นหัวใจปกติ (sinus rhythm – SR) ก่อนและหลังทำบอลลูนขยายลิ้นหัวใจเปรียบเทียบกับผู้ป่วยที่มีหัวใจเต้นผิดปกติแบบแผ่วระรัวจากห้องบน

วิธีการศึกษา : ผู้ป่วยจำนวน 145 รายที่ทำบอลลูนขยายลิ้นหัวใจด้วยวิธี Inoue ในโรงพยาบาลจุฬาลงกรณ์ ตั้งแต่ปี พศ. 2536 ถึง พศ. 2540 ข้อมูลที่ได้จะแสดงในรูปของค่าเฉลี่ย ± ค่าความเบี่ยงเบนมาตรฐาน และใช้ student *t*-test ในการเปรียบเทียบค่าของทั้งสองกลุ่ม

ผลการศึกษา : ผู้ป่วย 56 ราย (38.6%) มี AF ซึ่งผู้ป่วยกลุ่มนี้มีอายุมากกว่า (42.0 ± 11.3 กับ 32.4 ± 8.7 ปี, $p < 0.0001$) ขนาดของ atrium ข้างซ้ายโตกว่า (49.2 ± 6.1 กับ 45.3 ± 4.9 มม, $p = 0.001$) และมีหินปูนจับที่ลิ้นหัวใจมากกว่า (1.8 ± 0.6 กับ 1.5 ± 0.6, $p = 0.02$) เมื่อเทียบกับกลุ่ม SR, ไม่พบความแตกต่างของอัตราการเต้นของชีพจร และค่าคะแนนความผิดปกติของลิ้นหัวใจ จากค่า hemodynamic พบว่า กลุ่มที่เป็น SR มีค่าความดัน systolic (59.9 ± 26.0 กับ 47.4 ± 16.8 mmHg, $p < 0.05$), diastolic (28.1 ± 12.8 กับ 22.7 ± 9.2 mmHg, $p < 0.05$) และ mean (40.1 ± 17.1 กับ 32.7 ± 11.8 mmHg, $p < 0.05$) pulmonary artery (PA) สูงกว่ากลุ่ม AF ภายหลังจากทำบอลลูน กลุ่ม SR มีการเปลี่ยนแปลงค่าความดันของ PA และ ค่า transmitral valve gradient (10.0 ± 6.5 กับ 6.7 ± 6.5 mmhg, $p < 0.01$) ที่ดีกว่ากลุ่ม AF ไม่พบความแตกต่างในอัตราการทำหัตถการสำเร็จของทั้งสองกลุ่ม การตรวจด้วยคลื่นเสียงสะท้อนความถี่พบ atrial septal defect 18.2% ในกลุ่ม AF และ 7.5% ในกลุ่ม SR ($p = 0.08$) ไม่พบอุบัติการณ์ของการเกิดลิ่มเลือดหลุดไปอุดยังส่วนต่าง ๆ ของร่างกาย การตาย หรือ การที่ผู้ป่วยต้องไปทำผ่าตัดฉุกเฉิน

บทสรุป : ผู้ป่วยลิ้นหัวใจไมทรัลตีบที่มีการเต้นหัวใจผิดปกติแบบ AF มีอายุมากกว่า ขนาดของ atrium ข้างซ้ายโตกว่า แต่มีความดันของเส้นเลือดแดงที่ปอดต่ำกว่ากลุ่มที่หัวใจเต้นปกติ ผู้ป่วยที่หัวใจเต้นปกติจะมีการเปลี่ยนแปลงของ hemodynamic ไปในทางที่ดีกว่ากลุ่ม AF

คำสำคัญ : การทำบอลลูนขยายลิ้นหัวใจ, หัวใจเต้นผิดปกติแบบแผ่วระรัวจากห้องบน, หัวใจเต้นปกติ

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* หน่วยโรคหัวใจและหลอดเลือด, ภาควิชาอายุรศาสตร์, คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย, กรุงเทพ ฯ 10330