Percutaneous Balloon Mitral Valvulotomy with Transesophageal Echocardiographic Monitoring: Experience in Khon Kaen University

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Abstract

To study the results and complications of Percutaneous Balloon Mitral Valvulotomy with Transesophageal Echocardiographic monitoring in patients with symptomatic mitral stenosis. From November 1996 to November 1998, PBMV with TEE monitoring was performed in 107 patients with symptomatic mitral stenosis. There were 72 females and 35 males, aged 19 to 65 years (mean 37.63). The mitral valve was successfully dilated in 104 patients. Immediately after PBMV, there was significant reduction of mean mitral valve gradient (17.89 ± 6.7 mm Hg to 6.21 ± 3.02 mm Hg), mean left atrial pressure (26.67 ± 6.61 mm Hg to 13.97 ± 4.7 mm Hg), mean pulmonary artery pressure (35.21 ± 13.03 mm Hg to 27.71 ± 10.31 mm Hg). Mitral valve area was increased from 0.80 ± 0.24 cm^2 to 1.75 ± 0.42 cm^2 and cardiac output was increased from 3.84 ± 0.97 L/min to 4.74 ± 1.09 L/min. Mitral regurgitation was detected in 20 patients, severe mitral regurgitaion appeared in one patient. None of these patients required emergency surgery. Cardiac tamponade was detected in one case and resolved by pericardiocentesis. TEE was well tolerated and no complications of TEE were detected. PBMV aided by TEE is safe and well tolerated.

Key word : Transesophageal Echocardiography, Percutaneous Balloon Mitral Valvulotomy, Khon Kaen University

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Percutaneous Balloon Mitral Valvulotomy (PBMV) is a well established method of treating symptomatic mitral valve stenosis patients[1-4]. The serious complications of this procedure are cardiac perforation during interatrial septal puncture leading to cardiac tamponade, mitral valve regurgi-

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tation and cerebral emboli. Transseptal catheterization is an important technique of PBMV; therefore, a well performed transseptal catheterization is the key to a safe and successful of this procedure. Transseptal puncture is normally performed with fluoroscopic guidance; however, the radiologic landmark can be misleading. Transesophageal and transthoracic echocardiography have been used for guiding the transseptal needle across the atrial septum[5-7]. The objective of this study was to demonstrate the usefulness and safety of transesophageal echocardiography during PBMV.

METHOD

Patients

All patients with symptomatic mitral stenosis underwent a two-dimensional and Doppler echocardiographic evaluation of the mitral valve and any associated cardiac pathological features. The severity of mitral stenosis was assessed by the two-dimensional and pressure half time method. Mitral valve morphology was analyzed by the scoring system developed at the Massachusetts General Hospital[8]. Patients with left atrial thrombus, severe subvalvular lesion, severe calcified mitral valve, severe mitral regurgitation and patients who had contraindications for Transesophageal Echocardiography (TEE) were excluded from the study. Informed consent was obtained from all patients.

Percutaneous Balloon Mitral Valvulotomy

All patients underwent diagnostic left and right heart catheterization before PBMV. Intravenous heparin 2,000 units were given after the femoral vein and artery were punctured. Mitral valve area was calculated by two dimension transthoracic echocardiography or using Gorlin's formula. Cardiac output was measured in triplicate, using the thermo-dilution technique. PBMV was performed using the Inoue balloon catheter by the stepwise dilatation technique described by Inoue et al[1]. After the transseptal puncture was performed with an 8-F Mulin's dilator and Brockenbrough needle, 1,000 units of heparin were administered. The left atrial and ventricle pressure were recorded simultaneously. A stainless steel guided-wire with a coil floppy tip was advanced in the left atrium and used to place the Inoue catheter in the left atrium. After introduction of the balloon catheter into the left atrium, the distal half was slightly inflated with a diluted contrast media and a spring wire stylet was inserted into the catheter. The balloon was then manipulated through the mitral orifice into the left ventricle with fluoroscopic guidance. After each dilatation, left atrial pressure was measured with the balloon catheter and left ventricular pressure was measured with a 7-F pigtail catheter to assess the transmitral valve gradient. Repeat inflations with larger diametered balloons were performed until satisfactory hemodynamic results were obtained (transmitral valve gradient < 6 mm Hg) or significant mitral regurgitation developed[9]. The efficacy of the dilatation was assessed by transmitral valve gradient, auscultation, and two dimensional Color Doppler echocardiography. All hemodynamic measurements were repeated before the balloon catheter was removed from left atrium. After the balloon catheter was withdrawn, a right oximetry series and cardiac output were repeated. Mitral regurgitation was evaluated by left ventricular angiography and its severity was graded by Seller's classification[10].

Balloon Sizing

Because height was best correlated with the final balloon size in patient with pliable non-calcified mitral valves who did not develop significant mitral regurgitation after PBMV, the balloon catheter was chosen to cover a certain reference size as derived from a simple formula described by Hung et al[3]. The initial balloon size was reference size < 3 mm. In subsequent dilatations, the balloon size was increased by 1 mm.

Transesophageal Echocardiography

Multiplane TEE was performed during PBMV using a commercially available Ving-Med® echocardiography machine interfaced with 5 MHz tranducer, mounted on the tip of a modified gastroscope. After topically anesthetizing the posterior pharynx with 2 per cent Xylocain jelly and 10 per cent Xylocain spray, 2-5 mg of intravenous midazolam was administered. The TEE probe was introduce in the esophagus and positioned posterior to left atrium. The position of TEE was adjusted to visualize the maximal length of the interatrial septum. The transseptal needle with Mullin's sheath was directed to the thinnest

portion of interatrial septum. To confirm proper position, the atrial septum was expected to bulge toward the left atrial when the pressure was applied on transseptal catheter. Contrast echocardiography using 2-3 ml of 60 per cent urografin contrast media was performed to confirm the transseptal needle position in left atrium after the puncture. TEE was removed after the balloon catheter entered the left atrium.

Data and statistical analysis

Continuous variables were expressed as mean ± standard deviation. Student's paired *t*-test and chi - square tests were used for paired data. A p-value < 0.05 was considered as significant.

RESULTS

From November 1996 to November 1998, PBMV was performed in 107 patients with symptomatic mitral stenosis (72 females and 35 males, mean aged 37.63 ± 9.46 years, range 19 to 65). There were 44 patients with atrial fibrillation and 63 with normal sinus rhythm. One patient was in New York Heart Association functional class IV, 70 in class III and 36 in class II. Transseptal catheterization was successful and uncomplicated in 107 patients. The mitral valve was successful dilated in 104 patients (97%).

Hemodynamic Results (Table 1)

PBMV resulted in immediate improvement in the hemodynamic measurements of 104 patients, there was significant reduction of mean mitral valve gradient (17.98 ± 6.7 mm Hg to 6.21 ± 3.02 mm Hg), mean left atrial pressure (26.67 ± 6.61 mm Hg to 13.97 ± 4.7 mm Hg) and mean pulmonary artery pressure (35.21 ± 13.03 mm Hg to 27.71 ± 10.31 mm Hg). Mitral valve area increased from 0.80 ± 0.24 cm^2 to 1.75 ± 0.42 cm^2 and cardiac output increased from 3.84 ± 0.98 L/min to 4.74 ± 1.08 L/min. The mean post PBMV increase in valve area was 0.95 cm^2 ± 0.42 cm^2. An optimal outcome of PBMV defined as an improvement in valve area of 50 per cent or more or a final valve area of 1.5 cm^2 or more without significant mitral regurgitation was achieved in 103 patients (99.04%); a post PBMV valve area ≤ 1 cm^2 was obtained in only one patient (0.93%). The mean X-ray exposure time was 19.83 ± 10.76 minutes (range 4-57mins) and mean procedure time was 76.76 ± 19.84 minutes.

Technical failure and complications (Table 2)

Three technical failures occurred in this study: two because of failure to pass the balloon across mitral valve orifice and the other because of instrumental failure of a balloon catheter. Delayed cardiac tamponade after 6 hours of the procedure was detected in one patient which it was thought to be due to minor right atrial wall injury during catheterization. This was resolved by pericardiocentesis and 20 ml of bloody fluid was detected. Mitral regurgitation occurred in 20 patients (18.7%). Of this 20 patients, 1+ to 2+ mitral regurgitation was detected in 19 patients and 3+ in one patient. None of these patients required emergency surgery. Atrial septal defect with significant left to right shunt (pulmonary blood flow to systemic blood flow > 1.5:1) developed in 11 patients (10.5%). Right femoral vein thrombosis after PBMV confirmed by Doppler ultrasound occurred in one patient and resolved by intravenous heparin and oral anticoagulant in one week. None of the patient had excessive bleeding required blood transfusion. There was no hospital mortality in this study.

Table 1. Hemodynamic data before and after percutaneous balloon mitral valvulotomy.

	Before	After	p-value
MV area (cm^2), n=104	0.80 ± 0.24	1.75 ± 0.43	0.0001
Mean MV gradient (mmHg), n=104	17.98 ± 6.72	6.21 ± 3.02	0.0001
Mean LA pressure (mmHg), n=104	26.67 ± 6.61	13.97 ± 4.75	0.0001
Mean PA pressure (mmHg), n=97	35.21 ± 13.04	27.78 ± 10.31	0.0001
Cardiac output (L/min), n=65	3.84 ± 0.97	4.74 ± 1.09	0.0001

Table 2. Failure and complication rates (107 patients).

	Number of patients	%
Failure	3	2.80
Complications		
Cardiac tamponade	1	0.93
Mitral regurgitation		
Increased	19	17.75
Severe	1	0.93
ASD (>1.5:1)	11	10.50
Deep vein thrombosis	1	0.93
Thromboembolism	0	0
In- hospital mortality	0	0
Emergency surgery	0	0

DISCUSSION

Percutaneous balloon mitral valvulotomy has become a treatment of choice in patients with symptomatic mitral stenosis. The procedure itself is challenging and operator dependent, and a steep learning curve is also involved. There is a high success rate and low complication rate in experienced high volume center. The mortality of patients who underwent balloon valvulotomy in a large series has ranged from 1-2 per cent[11]. One of the major complications of PBMV was cardiac perforation that commonly occurred during the transseptal catheterization especially with inexperienced operator. In previous studies, technical failures and procedure related complications occurred more often during each operator's early experience[2-4]. The common causes of technical failures were transseptal failure and cardiac tamponade due to transseptal puncture. These failures ranged from 0.7-2.3 per cent. Normally, transseptal catheterization is performed with fluoroscopy guidance that can be missed especially in patients who have a large left atrium and a distorted interatrial septum. In experience of Kimura et al[12], cardiac tamponade occurred in 3 of 83 cases during transseptal puncture that carried out under fluoroscopic control. They tried to perform the puncture under simultaneous fluoroscopic and 2D-echocardiography guidance in order to decrease the rate of complications and found that no complications had occurred in 55 cases. Furthermore, 2D echocardiography indicated that directing the puncture needle toward 4 or 5 o'clock[13] was inappropriate direction for puncture of the fossa ovalis of a dilated left atrium. TEE provides a clear image of interatrial septum without interfering with catheterization techniques. The usefulness and safety of TEE during PBMV has been reported. In the study of Vilacosta et al,[6] PBMV with TEE monitoring performed in 35 patients with symptomatic severe mitral stenosis and another group of 27 patients who underwent PBMV without TEE were compared. The results demonstrated that TEE had a tendency to decrease the X-ray exposure time and well tolerated. The feasibility of on-line TEE during balloon mitral valvulotomy in 93 patients was reported by Goldstein et al[7]. In his study the TEE was well tolerated and no complications of TEE were detected. Major complications of PBMV were detected in 7 patients (severe mitral regurgitation, n=3; cardiac tamponade, n=1; large ASD, n=3).

In this study transseptal catheterization was successful in all patients. Only one patient developed delayed cardiac tamponade 6 hours after the procedure and resolved by bedside pericardiocentesis and drainage. Severe mitral regurgitation with stable hemodynamic occurred in one patient. None of the patients in this study needed emergency cardiac surgery. Hemodynamic results in this study were favorable, 103 patients (99.04%) achieved optimal mitral valve area, transmitral valve, mean left atrial pressure and mean pulmonary artery pressure were reduced significantly. There was no in-hospital mortality in this study. TEE was well tolerated in all patients and only minor complications such as sore throat, mild chest discomfort, transient tachycardia were detected. Compared with the previous studies of PBMV without TEE guiding, there were fewer complications of cardiac perforation and comparable hemodynamic outcomes; even though, we are in the learning curve of this procedure.

In conclusion PBMV aided by TEE during interatrial septal puncture has a low rate of complications and provides information that makes this interventional procedure safer to perform.

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การขยายลิ้นหัวใจไมตรัลโดยใช้บอลลูนผ่านทางผิวหนังร่วมกับการใช้เครื่องตรวจคลื่นเสียงสะท้อนหัวใจผ่านทางหลอดอาหารในมหาวิทยาลัยขอนแก่น

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การศึกษาผลของการรักษาและภาวะแทรกซ้อนต่างๆ ในการขยายลิ้นหัวใจไมตรัลโดยใช้บอลลูนผ่านทางผิวหนังร่วมกับการใช้เครื่องตรวจคลื่นเสียงสะท้อนหัวใจผ่านทางหลอดอาหารในผู้ป่วยลิ้นหัวใจไมตรัลตีบจำนวน 107 ราย เป็นหญิง 72 ราย เป็นชาย 35 ราย อายุตั้งแต่ 19 กับ 65 ปี (เฉลี่ย 37.63 ปี) การขยายลิ้นหัวใจประสบความสำเร็จจำนวน 104 ราย หลังการรักษาขนาดของลิ้นหัวใจไมตรัลเพิ่มขึ้นจาก 0.08 ± 0.24 ตร.ซม. เป็น 1.75 ± 0.43 ตร.ซม. ความดันในเอเตรียมซ้ายลดลงจาก 26.67 ± 6.61 มม.ปรอท เป็น 13.97 ± 4.75 มม.ปรอท ค่าความแตกต่างระหว่างความดันในเอเตรียมซ้ายและเวนตริเคิลซ้ายลดลงจาก 17.89 ± 6.72 มม.ปรอท เป็น 6.21 ± 3.02 มม.ปรอท ความดันในหลอดเลือดปอดลดลงจาก 35.22 ± 13.04 มม.ปรอท เป็น 27.78 ± 10.31 มม.ปรอท พบภาวะลิ้นหัวใจไมตรัลรั่วจำนวน 20 ราย ในจำนวนนี้ 1 รายเป็นลิ้นหัวใจรั่วชนิดรุนแรง เกิดภาวะบีบรัดหัวใจเนื่องจากมีเลือดออกในเยื่อหุ้มหัวใจ 1 ราย ไม่พบภาวะแทรกซ้อนที่เกิดจากการใช้เครื่องตรวจคลื่นเสียงสะท้อนหัวใจผ่านทางหลอดอาหาร

การศึกษานี้พบว่าการใช้เครื่องตรวจคลื่นเสียงสะท้อนหัวใจผ่านทางหลอดอาหารร่วมกับการขยายลิ้นหัวใจไมตรัลโดยใช้บอลลูนผ่านทางผิวหนัง ทำให้การรักษาด้วยวิธีนี้ได้ผลและมีความปลอดภัยมากขึ้น

คำสำคัญ : การขยายลิ้นหัวใจไมตรัล, ใช้บอลลูนผ่านทางผิวหนัง, ร่วมกับการใช้เครื่องตรวจคลื่นเสียงสะท้อนหัวใจผ่านทางหลอดอาหาร

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