PERCUTANEOUS BALLOON MITRAL VALVOTOMY WITH THE GUIDE OF TRANSESOPHAGEAL ECHOCARDIOGRAPHY DURING PREGNANCY

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Abstract- Rheumatic mitral valve stenosis is the most common form of organic heart disease encountered during pregnancy and continues to cause maternal and fetal mortality. Medically refractory congestive heart failure due to mitral stenosis is a clinical challenge and its optimal management remains controversial. On the other hand due to hazard of x-ray to mother and fetus, there are some limitations for perceutaneous balloon mitral valvotomy (PBMV) with fluoroscopy. Therefore, we performed PBMV with the guide of transesophageal echocardiography (TEE) with Inoue method in 18 pregnant women with NYHA class 3 or 4 due to mitral stenosis during pregnancy. The average procedure time was 29.9 (20-40) min and the average fluoroscopy time was 51.7 (28-101) seconds. The average NYHA class decreased from 3.11 to 1.33. There was no maternal or fetal complication or mortality and no premature delivery occurred. Overall risk to fetus was lower than previous reports of surgical commisurotomy performed during pregnancy. PBMV can be performed safely during pregnancy with the guide of TEE and is effective in reliving symptoms of severe congestive heart failure. It offers an effective alternative for the pregnant patients with severe mitral stenosis when congestive heart failure is not controlled by conventional medical treatment.

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INTRODUCTION

Rheumatic mitral valve stenosis is the most common form of organic heart disease encountered during pregnancy and continues to cause maternal and fetal mortality (1-4). Majority of the patients with moderate to severe mitral stenosis demonstrate a worsening of one or two classes in the NYHA functional class during pregnancy (1,5) and the pressure gradient across the narrowed mitral valve may increase greatly secondary to physiological increase in heart rate and blood volume of pregnancy (6). The optimal management of women with medically refractory congestive heart failure due to mitral stenosis remaines controversial (5). Surgical treatment is required when medical treatment fails to control symptoms of congestive heart failure in pregnant women with severe mitral stenosis (7,8). Closed or open surgical commissurotomy, however, carries significant risk of fetal death (8-11).

Percutaneous balloon mitral valyotomy (PBMV) was first performed in 1984 as an alternative to surgical mitral valve commissurotomy (12) and later reports confirmed the immediate and long term benefits of this procedure (13,14). PBMV has been shown to result in excellent immediate hemodynamic improvement in selected patients with mitral stenosis (15-19). The majority of PBMV procedures are being performed in developing countries (20, 21) where

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rheumatic fever and valvular heart disease continue to be endemic. Procedural mortality associated with mitral valvuloplasty ranges from 0 to 3 percent in most series and is primarily related to the development of left ventricular perforation (22), resulting from the transseptal technique or an advancement of the guide wire or balloon catheter into the left ventricle (22), or general patient comorbidity (23). Cerebral or coronary emboli occur in 0.5 to 5 percent of patients and are related to dislodgment of thromboembolic material from the left atrium or air within the dilatation apparatus (24).

Transthoracic echocardiography may be useful to assess the prognosis after PBMV by semiquantitative scoring of leaflet mobility, valvular and subvalvular thickening, and valvular calcification (25,26). Multivariable predictors of late events after PBMV are a high mitral valve echocardiographic score, an elevated left ventricular end diastolic pressure (LVEDP), and a high NYHA functional class (19, 27, 28). In a study by Cohen *et al.*, patients with fewer than two risk factors for early restenosis (echocardiographic score >8, LVEDP > 10mmHg or NYHA class 4) had a predicted 5 year event-free survival rate of 60-84%, whereas patients with two or three risk factors had a predicted 5 year event-free survival of only 13 to 41 percent (28). Severe mitral regurgitation (MR) resulting from rupture of the chordae tendinea or papillary muscle rupture may also occur. Atrial septal defects are commonly (80 percent) seen after PBMV, but the magnitude of the left to right shunt is generally insignificant (29, 30). Emergency surgery may be required in a minority of cases after PBMV. When emergency surgery is required for mitral regurgitation, left ventricular rupture, or development of a left to right shunt or as a result of a failed procedure, the mortality rate rises substantially (31,32).

Case reports suggest that PBMV may offer effective treatment for severe mitral stenosis during pregnancy (33, 34), with less risk of fetal death than surgical commissurotomy (35, 36). However, the data on PBMV during pregnancy are limited (37-42).

The purpose of this study is to prospectively examine the hemodynamic results and clinical outcome of pregnant women undergoing PBMV with the guide of transesophageal echocardiography (TEE) for treatment of NYHA class 2,3 or 4 congestive heart failure secondary to severe mitral stenosis. This study is unique due to use of TEE as the guide of procedure.

MATERIALS AND METHODS

From September 1993 to September 2000 a consecutive series of 18 pregnant women (mean age 28.88, range 18-35 years) underwent PBMV for treatment of rheumatic mitral stenosis at the cardiovascular department of Imam Khomeini hospital. We obtained informed consent from each patient.

We used Inoue method in all patients. Three patients had NYHA class 4 (16.5%), 14 had class 3 (77.7%) and one patient had class 2 (5%) symptoms of congestive heart failure not controlled by bed rest, diuretics, digitals and beta blockers. One patient had previous commissurotomy; others did not have a history of valvotomy. The severity of mitral stenosis and the morphology and scoring of the mitral valve and the presence of clot in left atrial appendage (LAA) or left atrium (LA) was assessed before valvotomy, using two-dimentional echocardiography and TEE and color flow Doppler echocardiography. The mean gestational age at the time of valvotomy, assessed by fetal ultrasound, was 20.22 (16-26) weeks.

Balloon Mitral valvotomy procedure

The day before performing procedure all patients had TEE for assessment of LA and LAA thrombus and patient tolerance. To limit fetal radiation exposure during the procedure, patients were wrapped during the procedure circumferentially in a lead apron covering the abdomen from the respiratory diaphragm to the symphysis pubis. The procedure was performed in catheterization lab. PBMV was performed in a transvenous antegrade fashion using the Inoue balloon technique (43). Transseptal catheterization of the left atrium was performed using the Brockenbrough technique with the guide of TEE. After septostomy the position of Brockenbrough was checked with fluoroscopy and tested with normal saline, and then 2500 unit heparin was given intravenously. Inoue guide wire and dilator and then Inoue balloon were introduced across the atrial

septum into LA and balloon positioned across the mitral valve annulus and checked with TEE and fluoroscopy and then balloon inflated stepwise.

The mitral valve gradient and pressure of LA was measured before and after valvotomy and the development of MR was checked with TEE. After procedure the atrial septum was checked for residual ASD. Forty eight hours after PBMV, two–dimentional and color flow Doppler echocardiography was repeated. Patients were evaluated monthly in follow-up by cardiologist and obstetrician. After delivery infants were followed at monthly intervals by a pediatrician.

RESULTS

The results are shown in table 1 and table 2.

Acute hemodynamic results

Immediately after balloon mitral valvotomy there was a decrease in the mean mitral valve gradient from 22 to 1.22 mmHg. This was associated with a decrease in left atrial mean pressure from 26.7 to 3.97mmHg.

Echocardiographic results

The mean mitral valve area assessed by Doppler increased from 0.82 cm^2 to 1.95 cm^2 after valvotomy.

Clinical results

Before valvotomy 3 patients (16.6%) were in NYHA class 4, one patient (5%) in class 2 and 14 (77.7%) patients in class 3; these figures decreased to 6 (33.3%) patients in class 2 and 12 (66.7%) in class 1 after valvotomy. The mean class of heart failure decreased from 3.11 to 1.33 and the patients became asymptomatic.

Table 1. Clinical results and procedural data

Pt No	Age	Rhythm	Gestational age(week)	NYHA class before PBMV	NYHA class after PBMV	Procedure time (min)	Fluorosopy time (sec)	Inflation time(sec)	Balloon size
1	26	Sin	24	4	2	38	98	4	28
2	23	Sin	17	3	2	35	60	5	28
3	19.5	Sin	19	3	1	40	72	3	28
4	35	Sin	26	3	1	25	45	3	28
5	28	Sin	18	3	1	35	52	5	28
6	24	Sin	20	3	1	30	33	4	28
7	25	Sin	19	3	2	41	101	3	30
8	25	Sin	17	3	1	22	80	3	30
9	26	Sin	18	2	1	20	45	3	30
10	30	AF	21	3	1	20	40	4	28
11	30.5	AF	22	3	1	30	32	5	28
12	31	AF	23	4	2	40	38	5	30
13	27	Sin	18	3	1	31	41	3	30
14	21	Sin	17	3	1	30	50	4	30
15	18	Sin	16	3	1	27	42	3	30
16	23	Sin	25	3	2	22	39	3	30
17	25	Sin	24	3	1	31	28	4	28
18	32	Sin	20	4	2	22	35	4	30

Abbreviations: PBMV, perceutaneous balloon mitral valvotomy; AF, atrial fibrillation.

Table 2. Hemodynamic and echocardiographic data

Pt No	Echo score	MVA before PBMV(cm^2)	MVA after PBMV(cm^2)	Gradient before PBMV(mmHg)	Gradient after PBMV(mmHg)	LAP before PBMV	LAP after PBMV
1	6	0.6	1.85	28	2	35	4
2	5	0.7	2.1	26	0	30	3
3	6	0.8	2	25	1	29	5
4	5	0.85	2	23	0	28	4
5	6	0.85	1.8	29	4	33	5
6	6	0.73	1.9	25	2	29	2
7	5	1	1.95	18	1	25	2
8	7	1.1	2	15	0	19	4
9	6	1.2	2.2	14	0	20	5
10	8	0.7	1.9	23	1	29	6
11	5	0.65	1.85	25	2	30	2
12	4	0.55	1.8	29	3	26	4
13	6	0.8	1.85	21	1	24	3
14	4	0.83	1.9	20	0	25	5
15	8	0.9	2.1	20	2	23	4
16	6	0.95	2	18	1	21	2
17	4	1	2.1	16	0	27	6
18	7	0.75	1.9	21	2	25	5
Average	5.77	0.82	1.95	22	1.22	26.7	3.97
Range	4-8	0.55-1.2	1.8-2.2	14-29	0-4	19-35	2-6

Abbreviations: MVA, mitral valve area; PBMV, perceutaneous balloon mitral valvotomy; MR, mitral regurgitation; LAP, left atrial pressure.

Complications and outcome

There were no acute hemodynamic or arrythmic complications. Color flow Doppler echocardiography performed 24 to 48 hours after valvotomy did not detect any abnormal flow across the atrial septum in any patient.

Mitral regurgitation, also evaluated by color flow Doppler echocardiography during follow-up, increased from 0 to 1 plus in 2 patients (patients 8 and 9) and from 0 to trivial in another two patients (patients 3 and 12) and did not change in the remaining 14 patients.

No abortions occurred during PBMV. During balloon inflation fetal heart rate and maternal blood pressure decreased transiently, but returned to baseline within a few seconds after balloon deflation. All patients were discharged from hospital within 2 days after the procedure. All women improved clinically and were in NYHA functional class one or two at the time of discharge or delivery.

Seventeen patients delivered at an average gestational age of 38±1 weeks, only one patient who was at NYHA class four delivered at gestational age of 37 weeks, with a normal infant. Fifteen patients delivered by vaginal delivery and three of them had cesarean section for obstetrical reasons (2 cephalopelvic disproportion and one breach presentation). The mean birth weight of the infants was 3.15 kg (2.5-3.6). Pediatric follow–up has shown normal growth and development of infants.

DISCUSSION

In our patients PBMV with the guide of TEE was performed safely during pregnancy, effectively relieving symptoms of severe congestive heart failure for the duration of pregnancy without the fear of radiation. PBMV performed during pregnancy produced excellent acute hemodynamic improvement. This hemodynamic improvement was associated with marked clinical improvement during the remainder of the pregnancy. The excellent hemodynamic results achieved in this study and the new valvular area which was achieved after procedure may be related to the underlying valve pathology. The limiting pathology in these young patient's valves is probably commissural fusion. The valves are unlikely to be heavily calcified or to have severe subvalvular thickening (mean echo score was about 5.77-range 4-8) in young patients.

Thus, unless there is significant valvular regurgitation, these valves (echo score below 8) may be quite amenable to PBMV. Because the pulmonary hypertension in mitral stenosis is potentially reversible, if mitral valve pathology is corrected at an early stage, the improvement in pulmonary hypertension may help reduce the maternal peripartum risk. No fetal abortion occurred during or after the procedure. Although balloon inflation caused transient maternal hypotension and transient decrease in fetal heart rate, these phenomena were well tolerated and both parameters returned to baseline within a few seconds of balloon deflation.

Surgical commissurotomy of the mitral valve during the pregnancy was first performed in 1952 (44,45). Since then, both open and closed commissurotoy have been performed for relief of mitral stenosis in pregnant women with severe congestive heart failure and symptoms that could not be controlled with medical treatment. Although open mitral commissurotomy has been performed with low risk to the mother, the attendant use of cardiopulmonary bypass and hypothermia has been associated with about 15-33% incidence of fetal death (9, 11, 46-48). In addition, the long term effects of cardiopulmonary bypass on the fetus are not known.

Closed mitral commissurotomy carries a low risk of fetal demise, although about 5 to 15% incidence of fetal abortion after surgery has been associated with this technique as well (10, 42, and 49). In addition, surgical experience with closed commissurotomy has declined over the last few decades in our country, because the technique has been largely replaced by open commissurotomy or PBMV in most centers.

PBMV is a technically complex procedure and carries significant risk. Death occurred in 1% of the cases of NHL and Blood institute's balloon valvuloplasty registry, usually as a result of perforation of LV with a guide wire (50). Our mortality rate in Imam Khomeini hospital and with Inoue balloon and method has been lower (51). Therefore this procedure should only be attempted in centers that have an extensive experience with balloon mitral valvotomy. In our experience, PBMV in pregnant women with the guide of TEE did not result in any mortality. PBMV during pregnancy introduces the risk of fetal radiation exposure. Precautions to minimize the radiation exposure should be taken. To obtain this goal we tried to perform valvotomy with the guide of TEE to minimize the radiation exposure time. We performed flouoroscopy only to verify the position of guide wire after septostomy. Fluoroscopic time was minimized and cineangiography avoided. The gravid uterus was shielded from direct radiation with a lead barrier wrapped around the mother's abdomen. The radiation time and the total procedure time were routinely measured. The average radiation time was about 51.72 sec (range 28 to 101), and total procedure time was about 29.9 min (range 20 to 40).

Animal and human data suggest that no increase in the incidence of congenital malformation or abortion occurs with fetal radiation exposure lower than 5 rads (52, 53). In all women the gestational age was more than 18 weeks. Thus, with proper precaution, the radiation exposure to the fetus can be kept quite small. The risk of even this small amount of radiation to the fetus is considered unknown and long term follow-up of these children is needed.

In conclusion, we can recommend PBMV with the guide of TEE in experienced hands and centers as the method of choice for relief of symptoms of congestive heart failure during pregnancy in women with mitral stenosis.

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