Transesophageal Echocardiography During Percutaneous Mitral Commissurotomy in Patients with Left Atrial Thrombus

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Abstract

Background : Transesophageal echocardiography (TEE) is used routinely before percutaneous transvenous mitral commissurotomy (PTMC) to detect left atrial appendage thrombus (LAAT) to avoid the risk of embolic complications. The issue of whether patients with small and fixed LAAT should be denied the potential benefit of PTMC is worth examining.

Objective : To evaluate the safety and efficacy of PTMC with Inoue balloon catheter in mitral stenosis patients with LAAT using TEE continuous monitoring during the procedure.

Material and Method : All TEE studies performed during PTMC and transthoracic echocardiography (TTE) performed the same day and repeated on the day after the procedure between March 1995 and January 2000 were reviewed.

Results : A total of 1,238 consecutive TEE during PTMC were reviewed. LAAT was detected in 111 patients (mean age 43.7 ± 10.1 years, male : female = 1 : 2, atrial fibrillation : sinus rhythm 2.47 : 1). LAAT were grossly oval with the largest measuring 3.5 x 2.8 centimeters. Mobile LAAT was detected in 3 patients (2.7%), one of whom developed a transient ischemic attack and another had an episode of stroke after PTMC. Mitral valve area (by 2D Echocardiography) pre PTMC was 0.8 ± 0.2 cm^2 and post-PTMC was 1.5 ± 0.3 cm^2. Most of our patients became fully ambulatory and could be discharged from the hospital the day after the procedure, except for two patients who developed severe mitral requrgitation and needed elective mitral valve surgery thereafter.

Conclusion : PTMC with the Inoue-balloon catheter can be carefully and safely performed in patients with small, fixed LAAT under continuous TEE guidance with acceptable risk.

Key word : Mitral Stenosis, Percutaneous Transvenous Mitral Commissurotomy, Left Atrial Thrombus

TANSUPHASWADIKUL S, SILARUKS S, HENGRUSSAMEE K, KEHASUKCHAROEN W, CHANTADANSUWAN T, SAEJUENG B
J Med Assoc Thai 2001; 84: 1534-1540

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Percutaneous transvenous mitral commissurotomy (PTMC) has gained widespread acceptance for alternative treatment of symptomatic mitral stenosis (MS). When regurgitation and valvular calcifications are limited, the presence of a left atrial (LA) thrombus is generally considered as a contraindication for this procedure[1-4]. Transesophageal echocardiography (TEE) offers better visualization of the LA appendage (LAA), and has a higher sensitivity for detection of thrombus than transthoracic echocardiography (TTE)[5]. TEE is now used routinely before PTMC to detect LA thrombi.

Whereas the risk of performing PTMC in the presence of a large thrombus located in the body of the LA is conceivably high, the impact of a small thrombus confined to the LAA is less clear. Whether such patients should be denied the potential benefits of PTMC and be subjected to mitral valve surgery is an issue of clinical interest and worth examining. There have been few studies of PTMC in patients with MS and LA thrombus demonstrating good results[5,6].

This study reports on the safety and efficacy of PTMC in patients with MS and LAA thrombus using TEE continuous monitoring.

MATERIAL AND METHOD

All TEE studies performed during PTMC and TTE studies performed the same day and repeated on the day after the procedure between 15 March 1995 and 21 January 2000 were reviewed.

Transthoracic echocardiography

All TTE studies were performed using a multi MHz transducer (Acuson Co., LTD.) with patients in the left lateral decubitus position. All of the standard views were recorded according to the American Society of Echocardiograpy guidelines[7]. The echocardiographic parameters included LA size measured by M-mode echocardiography, mitral valve area (MVA) measured by two dimensional planimetry and by continuous wave Doppler (pressure half time), and mitral valve echocardiographic score as described by Wilkens et al[8]. The severity of mitral regurgitation was assessed by using color flow mapping graded qualitatively on a scale of 0 to 4.

Transesophageal echocardiography

After informed consent was obtained, the TEE was performed either with a 5 MHz biplane or 5 MHz omniplane transducer, in awake patients in the catheterization laboratory. TEE was started after routine right sided cardiac catheterization and left ventriculogram, before transseptal puncture. After topical anesthesia to the oropharynx, a biplane or omniplane TEE probe was inserted and advanced to a depth between 30 and 40 cm from the toothline. When LAA thrombus was detected by TEE, its size and site were noted. A thrombus was accepted as such when its aspect was clearly distinct from the LAA pectinate muscles or the LA wall. The size in width by length (mm x mm) was recorded (Fig. 1). The mobility of LAA thrombus was noted as mobile or fixed. Spontaneous echocardiographic contrast (SEC) was described as absent or present.

Procedure and hemodynamic measurements

Before PTMC, right and left heart pressures, oximetry were obtained using a right femoral vein approach (7F Lehman) and a right femoral artery approach (6F pigtail). Left ventriculography in the 30 degree right anterior oblique projection was studied and mitral regurgitation was quantified according to the criteria of Seller et al[9].

A transseptal sheath and needle were introduced percutaneously *via* the right femoral vein and using fluoroscopic guidance, positioned as usual in the right atrium. After identifying the fossa ovalis by TEE, the transseptal puncture was performed with the tip of a standard Brockenbrough needle, followed by the sheath being carefully introduced into the left atrium. After left atrial access was achieved, 1,000-1,500 units of heparin was given intravenously (total dose of heparin during the procedure was 4,000 units). A 7F Inoue balloon-directed catheter (Toray Industries, Japan) was advanced and, using TEE guidance, directed carefully through the left atrium and across the mitral orifice. During this manipulation, the balloon catheter would occasionally move toward the LA appendage as visualized by TEE and was then immediately withdrawn and directed away to go through the mitral orifice. These images were monitored and recorded on videotape throughout the procedure.

After successful PTMC, the balloon catheter and the TEE probe were removed and hemodynamic measurements, left ventriculography, and oximetry were studied post-PTMC.

Statistical analysis

For normally distributed continuous variables, mean values and standard deviations were

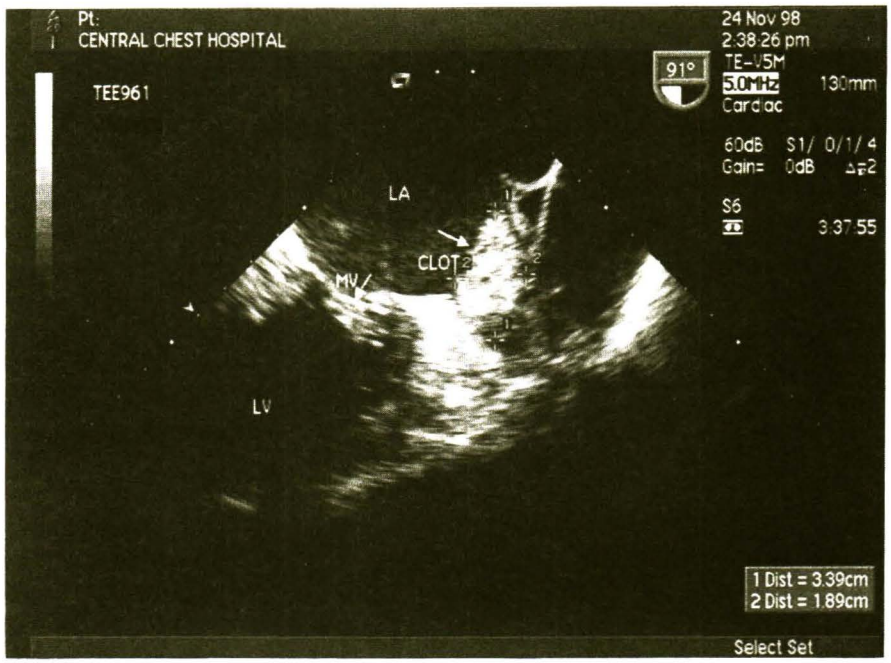

Fig. 1. Transesophageal echo shows clot in left atrial appendage, size 3.39 x 1.89 cm. LA = left atrium, MV = mitral valve, LV = left ventricle.

Tabel 1. Clinical characteristics.

Age (years)	25-70 (43.7+10.1)	
Sex (F:M)	74:37	
NYHA		%
Class II	89	80
Class III	22	20
Atrial fibrillation	79	71
Previous PTMC	7	6.3
Previous stroke	6	5.4

NYHA = New York Heart-Association,
PTMC = percutaneous transvenous mitral commissurotomy.

Table 2. TTE findings.

I. Echocardiographic score	1	2	3	4
Thickness	0	78	30	3
Subvalvular fusion	2	56	50	3
Immobility	10	74	27	0
Calcification	107	4	0	0
II. LAA thrombus 46/111 (41.4%)				

TTE = transthoracic echocardiography,
LAA = left atrial appendage

calculated and the means compared using the two sample *t*-test. For categorical variables, the significance of the differences between pre- and post-PTMC were compared using the chi-square test, with $p < 0.05$ taken to indicate statistical significance.

RESULTS

During the study period, 1238 consecutive patients underwent TEE during PTMC. A thrombus was detected in 111 patients (9%) The thrombus was confined to the LAA in all patients. Only 46 LAA clots had been detected by TTE.

Clinical date

Of the 111 patients who underwent PTMC despite a LAA thrombus, 79 were in atrial fibrillation. The mean age was 43.7 ± 10.1 years, which is comparable to the general population of the Balloon Valvuloplasty Registry (BVR)[1]. Seventy-four patients were women. All patients had been taking anticoagulants for at least 2 months, with four taking anticoagulants for more than 1 year. Four patients had a history of systemic embolization. The other clinical characteristics are demonstrated in Table 1.

Table 3. TTE and hemodynamic results n = 111.

	Pre-PTMC	Post-PTMC
I. TTE		
- LA size (mm)	32.7 ± 13.8	26.6 ± 15.4
- MVA - 2D (mm^2)	80.4 ± 21.5	147.3 ± 31.3 *
- Doppler (mm^2)	76.4 ± 22.9	141.2 ± 31.2 *
- MR - Gr II	0	8 (7.2%)
- MR - Gr III	0	1 (0.9%)
II. Hemodynamic		
- LAP (mmHg)	24.8 ± 7.3	16.3 ± 6.5 *
- MV Gradient (mmHg)	18.6 ± 7.2	11.8 ± 5.6 *
- PAP (mmHg)	32.5 ± 12.2	29.4 ± 9.1

LAP = left atrial pressure, PAP = pulmonary artery pressure,
MR = mitral requrgitation, * $P < 0.05$, TTE = transthoracic echocardiography,
LA = left atrium, MVA = mitral valve area, MV = mitral valve, 2D = two dimension

TTE findings (Table 2, 3)

Mean LA diameter was 32.7 ± 13.8 mm the mitral valve area (MVA) by 2D ranged from 39 to 129 mm^2 with a mean of 80.4 mm^2, and ranged from 30 to 123 mm^2 with a mean of 76.4 mm^2 by Doppler pressure half time. The echocardiographic score, as described by Wilkins et al[8], was used to evaluate calcification, mobility, thickness and chordal shortening. Each variable was given a grade from 1 to 4 for a possible total score ranging from 4 to 16. The total score in our patients ranged from 4 to 12 with a mean of 7.0, comparable to that of the general population undergoing PTMC.

TEE findings

LAA thrombus usually were grossly oval, the size varies from 3.0 x 1.9 mm to the largest measuring 28x35 mm. Mobile LAAT was found in 3 patients (2.7%). Spontaneous echographic contrast (SEC) was present in the LA in all cases.

Echocardiographic results (Table 3)

TTE post-PTMC showed a mean increase in MVA from 80.8 ± 23.7 mm^2 to 147 ± 31.3 mm^2. In 2 patients TEE showed mitral regurgitation grade II, and grade III respectively, both of whom needed elective mitral valve surgery.

The LAA thrombus was present at the end of the procedure without change in all cases.

Hemodynamic results (Table 3)

There were no special technical difficulties in performing PTMC in these patients. The hemodynamic results showed a significant decrease in both the mean LA pressure from 24.8 to 16.3 mmHg and the mean transmitral pressure gradient from 18.6 to 11.8 mmHg which is statistically significant by using the paired Student's *t*-test ($p < 0.05$).

Complications

No patient had cardiac tamponade. Two patients developed severe mitral regurgitation and needed elective mitral valve surgery.

Complications in any but one female patient with mobile LAAT who developed transient ischemic attack (TIA) of right hemiplegia immediately after PTMC and she had full recovery within 24 hours after the procedure. Another patient with mobile clot developed cerebrovascular accident after PTMC and was discharged later with mild residual right hemiparesis.

DISCUSSION

TEE has been now used routinely before PTMC to identify the presence and location of any LA thrombus. This is based on the assumption that during the transseptal catheterization, catheters and guide wires can be manipulated inadvertently into the LAA and dislodge a thrombus[10]. TEE has also been documented to be useful during the procedure in helping to more accurately position the transseptal needle, guide wires, balloon catheters, and to immediately evaluate the results of the procedure[10,11]. Furthermore, Kamalesh et al. has recently reported a successful PTMC with using TEE guidance to avoid a known LAA thrombus during the placement of wires and catheters[12]. Conti-

nuous TEE monitoring permitted excellent visualization of the balloon catheter during manipulation, assuring the correct position of the balloon across the mitral orifice, helping directed away from the known LAA thrombus.

In our series we performed PTMC in 111 cases, despite a LAA thrombus shown on TEE, with the Inoue balloon technique because of its special character[6], lowering the thromboembolic rates (0 to 1.4%) than other balloon catheters (3 to 4%) [3,4]. First, its coiled left atrial guidewire can prevent the catheter from entering the LAA. Second, its flow-directed passage from the left atrium to left ventricle can minimize manipulation of the catheter in the left atrium[6].

There were 2 out of 3 patients with mobile LAA clot who developed systematic embolization as a complication of PTMC. One had TIA and another one had a cerebrovascular accident. In the present study the improvement of echocardiographic mitral valve area and hemodynamic gradient were favorably comparable to that of the general population undergoing the same procedure[1]. None of our patients developed cardiac tamponade. Most patients became fully ambulatory and could be discharged from the hospital on the day after the procedure. Only two patients who developed severe mitral regurgitation needed elective mitral valve surgery thereafter.

TEE has been proven safe and is well tolerated[10]. Its major complications include aspiration, cardiac rhythm changes and, rarely, esophageal perforation[13]. However, in more than 2,000 cases of TEE experienced at our institution, the only complication was oropharyngeal discomfort. Using sedation and adequate local anesthesia, the period of prolonged TEE was only mildly uncomfortable to the patients.

The major benefit added by TEE to the standard TTE performed during PTMC is its higher sensitivity in detecting LA appendage clots, those previously missed by routine TTE examination in 65 out of 111 (59%) of our cases.

In conclusion, the present study suggests that PTMC with the Inoue-balloon catheter can be safely performed in mitral stenosis patients with a fixed LAA thrombus under continuous TEE guidance. With careful attention to level of sedation and respiratory status, the risk of this procedure should be minimal. With this technique, the authors feel that LAA thrombus may no longer be an absolute contraindication to PTMC, except for those with mobile LAA thrombus.

Limitations to this study are the relatively small number of cases studied and the clinical detection of embolic events. Cerebral or renal scans could have shown some emboli not detected clinically, although the clinical importance of such small emboli is uncertain.

(Received for publication on February 6, 2001)

REFERENCES

1. NHLBI Balloon Registry Participants. Multicenter experience with balloon mitral commissurotomy: the NHLBI Balloon Valvuloplasty Registry report on immediate and 30-day follow-up results. Circulation 1992; 85: 448-61.
2. Inoue K, Owaki T, Nakamure T, Kitamura F, Miyamoto N. Clinical application of transvenous mitral commissurotomy by a new balloon catheter. J Thorac Cardiovasc Surg 1984; 87: 394-402.
3. Vahanian A, Michel PL, Cormier B, et al. Results of percutaneous mitral commissurotomy in 200 patients. Am J Cardiol 1989; 63: 847-52.
4. Hung JS, Chern MS, Wu JJ, et al. Short- and long-term results of catheter balloon percutaneous transvenuos mitral commissurotomy. Am J Cardiol 1991; 67: 854-62.
5. Kronzon I, Tunick PA, Glassman E, Slater J, Schwinger M, Freedberg R. Transesophageal echocardiography to detect atrial clots in candidates for percutaneous transseptal mitral balloon valvuloplasty. J Am Coll Cardiol 1990; 16: 1320-2.
6. Chen WJ, Chen MF, Liau CS, Wu CC, Lee YT. Safety of percutaneous transvenous balloon mitral commissurotomy in patients with mitral stenosis and thrombus in the left atrial appendage. Am J Cardiol 1992; 70: 117-9.
7. Sahn DJ, DeMaria A, Kisslo J, Weyman A. Recommendations regarding quantitation in M-mode echocardiography: Results of a survey of echocardiographic measurement. Circulation 1978: 58; 1072-83.
8. Wilkins GT. Weyman AE, Abascal VM, Block PC, Palacios IF. Percutaneous mitral valvotomy : An analysis of echocardiographic variables related to outcome and the mechamism of dilatation. Br Heart J 1988: 60: 299-308.
9. Sellers RD, Levy MJ, Amplatz K Left retrograde cardioangiography in acquired cardiac disease: Technique, indications, and interpretation in 700 cases. Am J Cardiol 1964; 14: 437-43.
10. Kronzon I, Tunick PA, Schwinger ME, Slater J, Glassman E. Transesophageal echocardiography during percutaneous mitral valvuloplasty. J Am Soc Echocardiogr 1989; 2: 780-5.
11. Casale PN, Whitlow P, Currie PJ, Stewart WJ. Transesophageal echocardiography in percutaneous balloon valvuloplasty for mitral stenosis. Cleve Clin J Med 1989; 56: 597-600.
12. Kamalesh M, Burger AJ, Shubrooks SJ. The use of transesophageal echocardiography to avoid left atrial thrombus during percutaneous mitral valvuloplasty. Catheter and Cardiovascul Diagn 1993; 28: 320-2.
13. Aschenberg W, Schluter M, Kremer P, Schroder E, Siglow V, Bleifeld W. Transesophageal two-dimensional echocardiography for the detection of left atrial appendage thrombus. J Am Coll Cardiol 1986; 7: 163-6.

การใช้คลื่นสะท้อนความถี่สูงผ่านทางหลอดอาหารเฝ้าระวังระหว่างการขยายบอลลูนลิ้นหัวใจไมตรัลตีบ ในผู้ป่วยที่มีก้อนเลือดแข็งตัวอยู่ในห้องหัวใจ†

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ความเป็นมา : ปัจจุบันได้มีการใช้คลื่นสะท้อนความถี่สูงผ่านทางหลอดอาหาร ศึกษาว่ามีก้อนเลือดแข็งตัวอยู่ในห้องหัวใจหรือไม่ ก่อนทำการขยายลิ้นหัวใจด้วยบอลลูนผ่านทางผิวหนัง เพื่อช่วยลดอัตราเสี่ยงต่อการเกิดก้อนเลือดหลุดไปอุดตันส่วนต่าง ๆ ของร่างกาย แต่ยังไม่มีการศึกษาในผู้ป่วยที่มีก้อนเลือดในตำแหน่งซอกมุมห้องหัวใจเอเตรียมซ้าย ว่าสมควรได้รับการรักษาด้วยการใช้บอลลูนขยายผ่านทางผิวหนังหรือไม่

วัตถุประสงค์ : เพื่อศึกษาความปลอดภัยและประสิทธิผลของการรักษาผู้ป่วยลิ้นหัวใจไมตรัลตีบที่มีก้อนเลือดอยู่ในตำแหน่งซอกมุมห้องหัวใจเอเตรียมซ้าย ด้วยการใช้บอลลูน (ชนิด Inoue) ขยายลิ้นหัวใจ โดยใช้การศึกษาคลื่นสะท้อนความถี่สูงผ่านทางหลอดอาหาร เฝ้าระวัง ระหว่างการขยายบอลลูน

วิธีการ : ได้ศึกษาผู้ป่วยที่เข้ารับการรักษาด้วยการขยายลิ้นหัวใจไมตรัลตีบด้วยบอลลูน และได้มีการศึกษาคลื่นสะท้อนความถี่สูงผ่านทั้งทางทรวงอกและทางหลอดอาหารในช่วงเดือนมีนาคม 2538 ถึง มกราคม 2543

ผลการศึกษา : มีผู้ป่วยทั้งสิ้น 1,238 ราย ที่ได้ทำการศึกษาคลื่นสะท้อนความถี่สูงทางหลอดอาหาร ตลอดระยะการขยายบอลลูน โดยตรวจพบว่ามีก้อนเลือดอยู่ในตำแหน่งซอกมุมหัวใจเอเตรียมซ้ายในจำนวนผู้ป่วย 111 ราย (อายุเฉลี่ย 43.7 ± 10.1 ปี, ชาย : หญิง 37 : 74, จังหวะการเต้นหัวใจผิดปกติชนิดไม่สม่ำเสมอตลอด : จังหวะปกติ 79 : 32) ขนาดของก้อนเลือดในห้องเอเตรียมซ้ายแตกต่าง โดยมีขนาดใหญ่สุด 3.5 x 2.8 เซนติเมตร พบก้อนเลือดมีลักษณะแกว่งไปมาในผู้ป่วย 3 ราย โดย 2 ราย เกิดภาวะแทรกซ้อน จากก้อนเลือดหลุดไปอุดตันหลอดเลือดในสมองหลังการขยายบอลลูน (1 ราย อาการผิดปกติทางระบบประสาทหายเป็นปกติใน 24 ชั่วโมง, อีก 1 ราย อาการทางระบบประสาทยังคงอยู่) ขนาดรูเปิดของลิ้นหัวใจไมตรัลก่อนขยายบอลลูน 0.8 ± 0.2 ตารางเซนติเมตร หลังขยาย 1.5 ± 0.3 ตารางเซนติเมตร ผู้ป่วยเกือบทุกรายสามารถจำหน่ายออกจากโรงพยาบาลได้ภายใน 24 ชั่วโมงหลังการรักษา ยกเว้น ผู้ป่วย 2 รายเกิดลิ้นหัวใจไมตรัลรั่วรุนแรง และได้รับการรักษาด้วยการผ่าตัดเปลี่ยนลิ้นหัวใจ

สรุป : การรักษาด้วยผู้ป่วยลิ้นหัวใจไมตรัลตีบ ที่มีก้อนเลือดขนาดเล็กและอยู่ในตำแหน่งซอกมุมห้องหัวใจเอเตรียมซ้าย สามารถกระทำได้อย่างระมัดระวัง โดยใช้บอลลูน (ชนิด Inoue) ขยายลิ้นหัวใจ ร่วมกับการเฝ้าระวังระหว่างการขยายลิ้นหัวใจด้วยการใช้คลื่นสะท้อนความถี่สูงผ่านทางหลอดอาหาร โดยเกิดภาวะแทรกซ้อน หรือมีอัตราเสี่ยงน้อย

คำสำคัญ : การขยายลิ้นหัวใจไมตรัลตีบด้วยบอลลูน, ก้อนเลือดแข็งตัวในห้องหัวใจเอเตรียมซ้าย, การใช้คลื่นสะท้อนความถี่สูงทางหลอดอาหารเฝ้าระวัง

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