TECHNICALLY DEMANDING INOUE-BALLOON MITRAL COMMISSUROTOMY: BROADENED INDICATIONS FOR THE PROCEDURE

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ABSTRACT

Although percutaneous transvenous mitral commissurotomy (PTMC) is now the preferred treatment modality for selected patients with mitral stenosis, there are certain settings where its application remains controversial or even contraindicated, mainly because of an increased risk of major complications. In this report, 3 such complex PTMC cases are described.

A 39-year-old female with a rare combination of mitral stenosis and concomitant sizeable atrial septal aneurysm underwent a successful PTMC procedure. PTMC in a 60-year-old female with coexisting severe kyphoscoliosis which required major adjustments to the transseptal technique yielded an improvement in the mitral valve area from 1.0 cm^2 to 1.9 cm^2. In the third patient who was in her 25th week of gestation and had evidence of congestive cardiac failure, an abbreviated and expeditious PTMC procedure was carried out uneventfully.

The 3 cases reported here highlight the feasibility, safety and efficacy of complex PTMC in the presence of atrial septal aneurysm, severe kyphoscoliosis and pregnancy.

Keywords: *mitral stenosis, atrial septal aneurysm, kyphoscoliosis, valvuloplasty, pregnancy.*

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INTRODUCTION

The last decade since the introduction of percutaneous transvenous mitral commissurotomy (PTMC)[1] has been characterised by a phenomenal growth in the application of the procedure[2,3] by well-demonstrated safety, short-and long-term efficacy of the procedure[2-4] with results which are comparable with those of closed[5-7] and open surgical commissurotomy[8] in various randomised trials and *ipso facto*, the establishment of PTMC as the treatment modality of choice in selected patients with rheumatic mitral stenosis. Furthermore, with increasing operator experience and confidence, PTMC has expanded appreciably to include not only ideal pliable, noncalcific mitral valves where the results of PTMC are predictably favourable, but also valves with adverse morphologies, such as those which are calcified, immobile and associated with extensive subvalvular disease as assessed by echocardiographic and angiographic methods[2,3,9-12]. Even in this latter group of valves, PTMC has continued to produce satisfactory results in a substantial minority of patients[2,3,9-12].

Despite its undisputed therapeutic role, there are, nevertheless, certain clinical scenarios where the role of PTMC is highly controversial, primarily because of increased technical complexity and its associated potential for untoward effects[3]. Examples include the performance of PTMC in patients with coexisting significant atrial septal aneurysm, marked kyphoscoliosis and those who are pregnant. In this report, we describe 3 successful PTMC procedures performed in such controversial settings.

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PATIENT DESCRIPTION (TABLE I)

Patient 1 (Atrial septal aneurysm)

A 39-year-old Chinese female was referred for further management of her symptomatic mitral stenosis associated with NYHA functional class III symptoms. Clinically, she was in sinus rhythm with a moderately prolonged mid-diastolic murmur preceded by an opening snap. Baseline 2-dimensional echocardiogram revealed a mitral valve area of 1.1 cm^2 and the presence of a discrete atrial septal aneurysm (ASA) which was subsequently confirmed and clearly delineated by transesophageal echocardiogram. The ASA measured 2.9 cm at the base and projected 1.1 cm into the right atrium (Fig 1A). No thrombus was present either in the ASA or the left atrium. After written, informed consent, a biplane right angiogram with visualisation of the left atrium in levophase was performed immediately prior to Inoue-balloon PTMC as described in detail previously[10,12]. The ASA was defined (Fig 1B) and a puncture site superior to it - this was later confirmed on transthoracic echocardiography - was selected. Successful PTMC was performed, enlarging the mitral valve from 1.1 cm^2 to 2.3 cm^2. This was associated with substantial symptomatic improvement. Oximetry performed immediately after the procedure showed no interatrial shunting.

Patient 2 (Kyphoscoliosis)

A 60-year-old Chinese female with symptomatic mitral stenosis and concomitant severe kyphoscoliosis (Fig 2A) was referred for PTMC after she had refused surgical intervention. Her underlying cardiac condition was diagnosed in July 1993

Table I – Baseline and Procedure-related characteristics of patients

Pt No.	Age (Yr)	Sex	Rhythm	ES	LAS (cm)	MVA (cm^2) Pre	MVA (cm^2) Post	MG (mmHg) Pre	MG (mmHg) Post	Compl	Coexisting condition
1	39	F	SR	6	4.7	1.1	2.3*	6	2	Nil	ASA (1.1 x 2.9cm)
2	60	F	AF	8	7	1.0	1.9**	8	2	Nil	Kypho-scoliosis
3	21	F	SR	4	5	0.8	1.6**	18	4	Nil	25 week gestation

* based on haemodynamic estimate; **based on echocardiographic methods AF, atrial fibrillation; Compl, complications; ES, echo-score; F, female; LAS, left atrial size; MG, mitral gradient; MVA, mitral valve area; post, after valvuloplasty; pre, before valvuloplasty; SR, sinus rhythm.

Fig 1 – Patient 1: (A) Transoesophageal echocardiographic view clearly demonstrating the atrial septal aneurysm (arrows) bulging into the right atrium (RA). (B) Follow-through right atrial angiographic freeze-frame in the right anterior oblique projection depicting the atrial septal aneurysm (arrows). LA, left atrium.

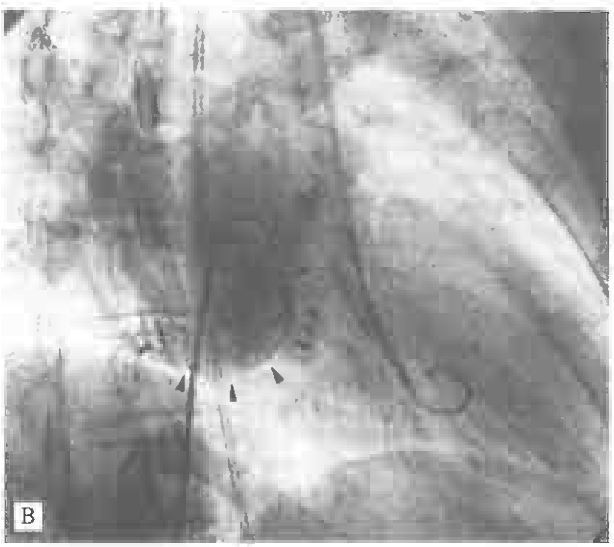
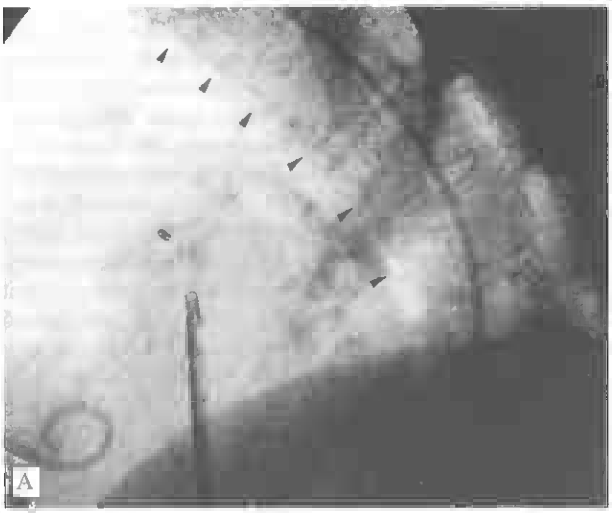
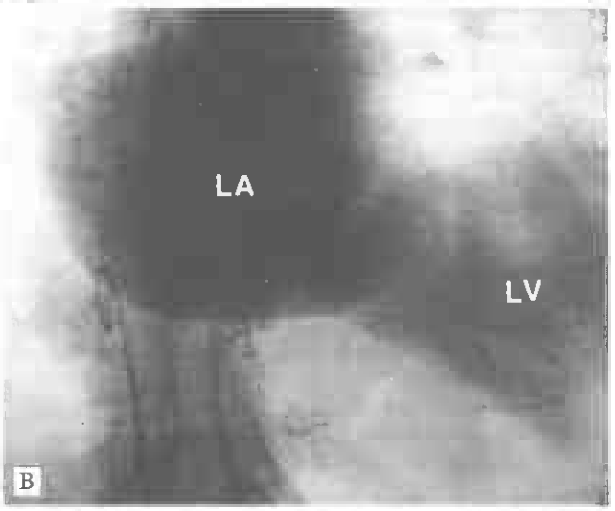
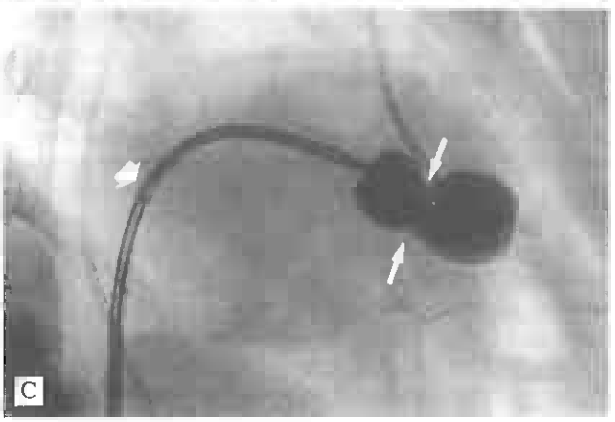


Fig 2 – Patient 2: (A) Lateral view of the thoracic spine showing the severe kyphosis (arrow heads). The distal end of the Inoue balloon catheter and the pigtail catheter are in the left atrium and the ascending aorta, respectively. (B) Frontal view of the right atriogram with levophase demonstrating the large left atrium (LA) and the horizontally oriented left ventricle (LV). The tip of the pigtail catheter is positioned in the right atrium. (C) 30° right anterior oblique projection showing the indentation of the Inoue balloon at its mid-segment (white arrows) as it is being inflated across the tight mitral valve. Because of the large left atrium and the horizontally oriented left ventricle, the transseptal puncture site (white broad arrow) is selected on the same horizontal level as the mid-point of the mitral valve rather than above it in order to enable the Inoue balloon to traverse the mitral valve smoothly.





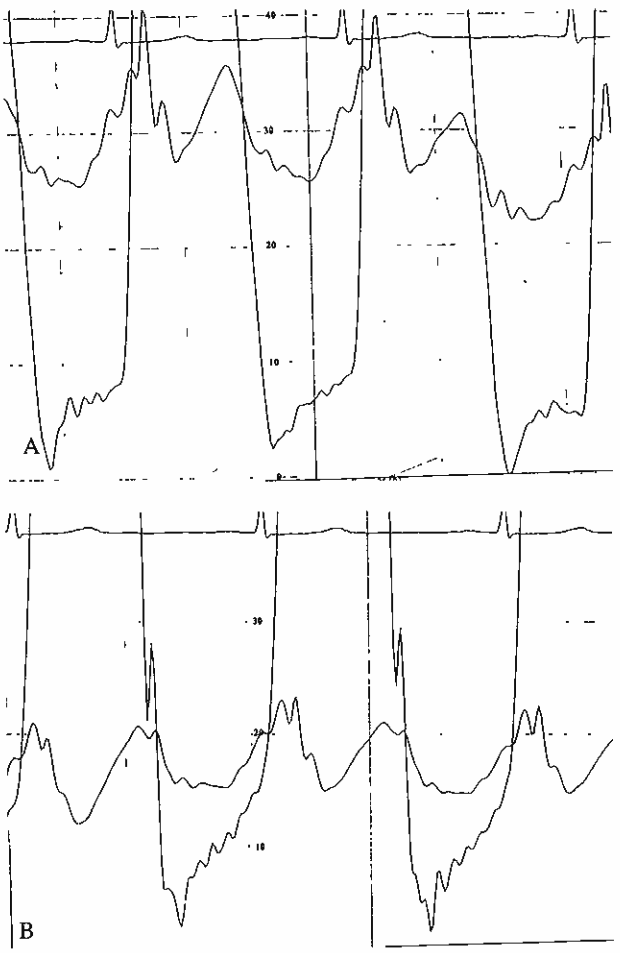


when she developed a left cerebrovascular event with resultant dense right hemiplegia and has since been on long-term oral anticoagulation without recurrent cardioembolism. Physical examination revealed atrial fibrillation and evidence of severe mitral stenosis. This was confirmed by transthoracic echocardiography which showed a mitral valve area of 1.0 cm^2 and a large left atrium of 7 cm in dimension. A trans-oesophageal echocardiogram just prior to PTMC demonstrated copious amount of spontaneous echo within the left atrium but no thrombus. A one-stage diagnostic and PTMC procedure was performed successfully. During the procedure, because of the marked kyphoscoliosis, the patient had to be placed in a semi-recumbent position of about 40° to the horizontal. Left ventriculography showed a horizontally orientated heart with no evidence of mitral regurgitation. A biplane right atrial angiogram with visualisation of the left atrium in levophase (Fig 2B) allowed an optimal transseptal puncture site to be selected. A 24-mm Inoue balloon catheter was chosen and stepwise dilatation was performed until satisfactory haemodynamic results were obtained. Post-PTMC left ventriculogram showed no increase in mitral regurgitation. The mitral valve area on echocardiography had increased to 1.9 cm^2. The procedure and hospital stay were uneventful.

Patient 3 (Pregnancy)

A 21-year-old Malay female in her 25th week of pregnancy was found to have severe mitral stenosis with resultant congestive cardiac failure which responded partially to digoxin and diuretic therapy. Pre-procedural echocardiography showed a stenotic mitral valve with favourable morphology and a valve area of 0.8 cm^2. Because of the high likelihood of adverse cardiac complication later in pregnancy, namely that of acute pulmonary oedema and its attendant morbidity and mortality, PTMC was considered, and informed, written consent obtained after the potential risks of the procedure were discussed with the patient and the immediate family members. The patient was wrapped with a 10-mm thick lead apron from the level of the diaphragm to the pubic symphysis and an abbreviated PTMC procedure was performed. To curtail irradiation, no right heart studies and cineangiography including left ventriculography were performed. The procedure was successfully completed without any complication, reducing the mean transmitral gradient from 18 mmHg to 4 mmHg (Fig 3). The total screening time was 5.9 minutes. The post-PTMC mitral valve area determined by echocardiographic methods was 1.6 cm^2. At 1-month follow-up, the patient was asymptomatic and the foetus was developing normally.

Fig 3 – Patient 3: Simultaneous left atrial and left ventricular pressure tracings (A) before and (B) after PTMC displaying the significant reduction in the transmitral gradient after successful dilatation.



DISCUSSION

In this report we demonstrate the feasibility and efficacy of Inoue-balloon PTMC in three technically complex situations: atrial septal aneurysm, severe kyphoscoliosis and pregnancy.

PTMC in atrial septal aneurysm

The coexistence of mitral stenosis and ASA is extremely rare[13,14]. To date, excluding the present one, only 3 other cases of PTMC in such a setting have been reported; these include the 2 cases optimally dilated and recently reported by us[15] and another by Yeh et al[16].

PTMC in the presence of ASA poses a number of problems. First, as PTMC requires introducing the entire balloon catheter assembly across the atrial septum, the intrinsically thin-walled and fragile ASA may tear in the process, thereby creating a large atrial septal defect[15]. The potential for the latter complication is theoretically lower with the Inoue-balloon system which allows for slenderisation of the balloon segment prior to introducing and withdrawing the catheter across the septum unlike the double-balloon PTMC technique which mandates predilatation of the atrial septum with either a 5-mm or 8-mm balloon[3]. Second, securing an optimal septal puncture site in the presence of a smooth aneurysmal protrusion in the right atrium may be technically difficult or even impossible, particularly if the ASA is enormous. A suboptimal puncture site, in turn, accentuates the complexity of the procedure by hindering or preventing the smooth negotiation of the Inoue balloon across the mitral valve[17]. Third, because of the association between ASA, localised thrombus and cardioembolism[18,19], PTMC performed in such a setting may increase the risk of an embolic event. The routine use of pre-procedural transoesophageal echocardiography which is extremely sensitive in detecting left atrial thrombus has, however, eliminated this risk. The success of our case reinforces the safety and efficacy of PTMC in the presence of ASA.

PTMC in severe kyphoscoliosis

Our second patient was technically challenging because of multiple anatomic aberrations which include severe kyphoscoliosis necessitating the patient to lie in a semi-recumbent position during the procedure, and the combination of an enlarged left atrium and a horizontally orientated heart It also focuses on the need to modify the conventional PTMC

approach, particularly the transseptal technique - an essential part of PTMC - in order to facilitate the procedure and to prevent any major complication from occurring in such a situation.

Severe kyphoscoliosis distorts the spatial relationship of the intracardiac and neighbouring structures, making transseptal puncture potentially hazardous in terms of an increased risk of inadvertent cardiac perforation, tamponade and even death. Thus, not surprisingly, thoracic spinal deformity has been traditionally considered a contraindication to the procedure[20]. Perhaps, because of this discouraging high degree of complexity and heightened risk of cardiac perforation, interventionalists have been deterred from performing PTMC in these patients. This is clearly evident by the fact that only one such report[21] has been published in the literature to date. Although we[4] and others[17] do not routinely use right atrial angiogram to delineate the primary puncture transseptal site in "straightforward" PTMC cases, in such a complicated setting, this precautionary additional step is strongly advocated to mimimise the unnecessary risk of cardiac perforation and to optimise the puncture site for a smooth passage of the Inoue balloon across the mitral valve.

To further enhance the complexity of the procedure, our patient had a large left atrium and a horizontally orientated heart (Fig 2b). Both these anatomic distortions require the transseptal puncture point to be adjusted more caudally to ensure a smooth trajectory for the Inoue balloon to cross the mitral valve[17]. However, when puncturing more caudally than is usual, it is imperative that the puncture point should never be too caudal relative to the level of the midpoint of the mitral valve (Fig 2c) and the atrial septum should be clearly defined by the "flush-and-stain" method[17]; failing to do so may predispose to right atrial perforation. In our patient, all the necessary precautionary steps and adjustments were exercised. The mitral valve was successfully dilated without sequelae.

PTMC in pregnancy

Pregnancy in the presence of severe mitral stenosis is a potentially dangerous combination, and may result in acute pulmonary oedema with its attendant risk of maternal and foetal wastage[22,23]. In the past, surgical treatment is required when medical therapy fails to control symptoms of congestive cardiac failure. Recently, however, PTMC has been used in a *limited* number of pregnant patients with significant mitral stenosis who were symptomatic despite aggressive medical therapy[24-26]. The results, although favourable, should nevertheless be considered preliminary at this stage. Compared to surgical commissurotomy which is associated with a high incidence of foetal loss[27,28], the data on PTMC in pregnancy, albeit small, suggest that the procedure is effective and relatively safe provided certain precautions are adhered to, as illustrated in Patient 3. First, the gravid uterus should be maximally shielded from direct irradiation with a lead barrier (10-mm in thickness) wrapped around the abdomen from the diaphragm to the pelvis. Second, because of the potential teratogenic hazards to the foetus from irradiation, the procedure is best avoided until organogenesis is completed (about 5 months after conception) unless the patient is severely symptomatic and refractory to optimal medical therapy; the procedure should, furthermore, be performed only by interventionalists who are skilled in the transseptal and PTMC techniques, and carried out expeditiously with minimum fluoroscopy, cineangiography avoided and right heart studies discarded. The Inoue technique seems particularly suited in this setting as it is technically simpler to perform, involves less fluoroscopy and yet is no less effective than the double-balloon approach[2,3]. With these proper precautions, the radiation exposure to the foetus appears small. Third, even in less favourable valve morphologies, PTMC in pregnancy is an acceptable strategy where the goal is palliation. In the latter scenario, a small increase in valve area is sufficient to produce haemodynamic and symptomatic improvement, thus allowing the pregnancy to proceed safely to term and thereby producing healthier infants at birth.

CONCLUSION

The combination of increased operator experience, technical refinements[29] and proven excellent short and long-term efficacy of PTMC, particularly in comparison with surgical commissurotomy, has allowed the spectrum of indications for PTMC to expand appreciably. In skilled centres, certain anatomic or clinical settings which were once deemed controversial or contraindicated, as exemplified in this case report and elsewhere in the literature, are now being considered for the procedure.

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