



Original Article

Difficulties to enter the left ventricle during percutaneous transvenous mitral commissurotomy (PTMC)- our experiences of 80 cases with modified techniques



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ABSTRACT

Background: Percutaneous transvenous mitral commissurotomy (PTMC) is the standard of treatment for symptomatic severe rheumatic mitral stenosis (MS). PTMC has the standard Inoue technique, but we have to modify the procedure in many technically challenging cases, especially to cross the mitral valve.
Methodology: Two over-the-wire strategies to enter the LV were taken in 80 complex cases of PTMC. The first one was done by exchanging the J-shaped wire from the balloon, introducing the spring wire into it, and pushing it into LV. The second one-removal of balloon keeping the spring wire in LA and the Mullin's sheath was introduced, and the tip of the wire was pushed into LV, and the balloon was introduced over the wire. We also changed the left atrium (LA) graphy in the RAO view instead of the AP view to facilitating entry into LV.

Results: We succeeded in 76 (95 %) cases. Strategy one was applied to all but successful in only 25 cases (31 %), and strategy 2 was applied in the remaining. Strategy 1 required less procedural time and fluoroscopic time in comparison to strategy 2 (40 ± 10 vs 60 ± 16 min, 25 ± 7 vs 35 ± 8 min). After modification of taking the LA graphy in RAO view, our rate of facing the difficulties decreased from 21 % to 9 %. Critical MS (31 %) and the giant LA (30 %) were the topmost causes of difficulties. No major complications were recorded.

Conclusion: Over-the-wire entry into LV is cost-effective, requiring no new equipment and is safe and can be used in complex cases.

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1. Introduction

Rheumatic mitral stenosis (MS) remains the most frequent valvular disease in developing countries, where it involves mostly young adults. The prevalence of rheumatic heart disease in school-age children is estimated at between 1 and 6 per 1,000 in Asia and between 3 and 14 % in Africa.^{1–3} True prevalence may be approximately tenfold higher based on the echocardiographic data.⁴ Though the incidence of rheumatic fever is decreasing with the improvement of socioeconomic status, as a national institute, our

centre still deals with many cases of rheumatic mitral stenosis. Percutaneous transvenous mitral commissurotomy (PTMC) is the standard of treatment for symptomatic severe rheumatic MS in suitable cases with long-term follow-up data is equivalent to surgical commissurotomy. The efficacy, safety, and applicability of the Inoue balloon technique are clearly established worldwide, and since its first report in 1984, a considerable evolution in the technique has occurred, and this technique is currently the point of reference for PTMC. PTMC shows good immediate and long-term clinical results and carries a low risk when performed by experienced teams. The failure rate ranges from 1 % to 17 %.^{5–17} Failure is mostly caused by an inability to puncture the atrial septum or to position the balloon correctly across the mitral valve (MV). The standard method to cross the MV in the Inoue technique is to

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manoeuvre the J-shaped stylet through the balloon. Despite reshaping the stylet and adopting the 'loop method,' it may be challenging to cross the MV even in very experienced hands. We are dealing with these cases where the left ventricular (LV) entry is difficult, and we have to modify the standard Inoue technique. This difficulty is generally encountered in patients with critical mitral stenosis (mitral valve area, MVA $<0.5 \text{ cm}^2$) or in patients with an abnormal puncture site due to gross interatrial septal bulge. Over the wire entry into LV was describe by Meier¹⁸, Mehan and Meier¹⁹ and Manjunath et al.²⁰ The first two procedure is complicated and needs more time and hard wires. Therefore, we took 2 over-the-wire strategies, which are simple involving no other equipment and our second strategy is like that of Manjunath's technique.

2. Materials and methods

As a national institute, our centre does the highest number of PTMC in the country and from 2015 to 2019, a total of 505 cases were done. In total 80 (16 %) cases, we faced difficulty entering the LV using the standard technique. For all cases, we used the standard Inoue technique, including puncturing both right femoral artery and vein, puncturing the interatrial septum by the Brocken borough technique; after septal dilation, an Inoue balloon catheter was introduced into the left atrium (LA) over the coiled guidewire (0.025-inch Inoue spring guidewire). Routinely the standard technique is to do LA graphy through the Mullin's sheath to confirm the position of the sheath in the LA taken in the AP view. In the last two years, we changed our usual practice and started to take the LA graphy in RAO as we enter the LV across the MV in RAO view, and this change helped to localize the MV orifice to enter the LV (Fig. 1). However, repeated attempts at crossing the mitral valve by the standard Inoue technique were unsuccessful, despite changing the shape of the J-shaped guiding stylet. The Loop technique was not in practice in our lab. Then we had to modify the standard procedure to enter the LV.

We used two over-the-wire strategies to enter the LV. The first one was done by exchanging the J shaped wire from the balloon, introducing the spring wire into the balloon, keeping the tip of the wire protruding through the tip of the balloon into the orifice of the mitral valve and pushing the wire during diastole into the LV (Fig. 2). The second strategy needed removal of balloon keeping the spring wire into LA, the Mullin's sheath was introduced over the wire, and the tip of the wire was directed towards the MV orifice, and it was pushed during the diastole to enter the LV, the sheath was removed quickly, and the balloon was introduced over the wire into LV (Fig. 3). The final echocardiographic assessment was done on the second post-procedural day before the discharge.

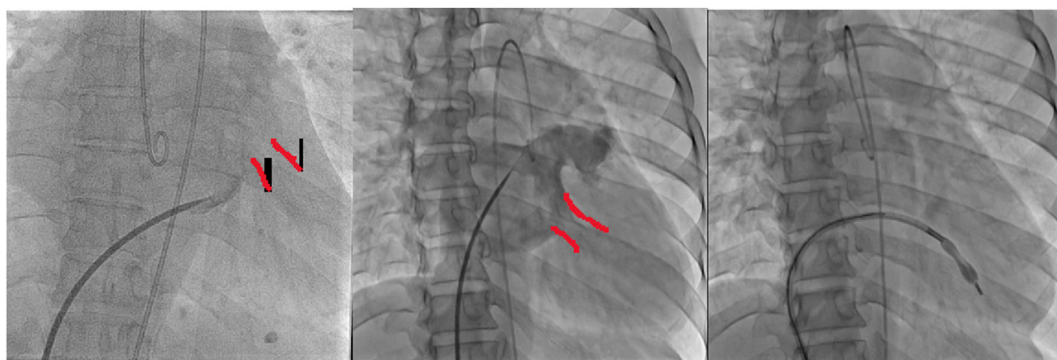


Fig. 1. a. The LA graphy taken in AP view to confirm the location of Mullin's sheath after successful puncture also visualized the MV orifice, and when we went to the RAO view, the orientation of the MV orifice changed and did not help to cross the MV orifice. b. The LA graphy taken in RAO view and orientation of MV did not change and helped to cross the MV.

3. Results

Baseline characteristics of 80 cases were given in Table 1. The average age was 30 ± 12 years, with 62 % of patients were female. Wilkin's scoring system was done in all cases, and the mean score was 8.1 ± 0.8 . Mild mitral regurgitation (MR) was present in 25 % of the cases, and atrial fibrillation was present in 42.5 % of cases. Possible causes of difficulties to cross the MV are given in Table 2 and Fig. 4. Critical MS (MVA $<0.5 \text{ cm}^2$) and the giant LA size (LA diameter $>55 \text{ mm}$) were the topmost causes, followed by low septal puncture and thickened septum. In some cases, causes could not be sorted out, and in other cases, multiple causes might be present.

Out of 80 complex cases we attempted with modified strategies, we succeeded to cross the MV in 76 with a success rate of 95 %. Failed cases were referred for closed mitral commissurotomy or mitral valve replacement. Wilkin's score was not significantly different in these failed cases than in successful cases. Strategy one was applied first in all cases but successful in only 25 cases (31 %). Strategy 2 was applied in the remaining. The mean procedural time was 50 ± 19 min and the mean fluoroscopic time 30 ± 9 min including the time lapsed during the initial failed attempts. Strategy 1 required less procedural time and fluoroscopic time in comparison to strategy 2 (40 ± 10 vs. 60 ± 16 min and 25 ± 7 vs. 35 ± 8 min, respectively). After modifying the LA graphy in the RAO view, which visualized the MV orifice, our rate of facing the difficulties to cross the MV decreased 60 in 290 cases (21 %) before the modification vs. 20 in 215 cases (9 %) after the modification.

Per procedural data and echocardiographic data (taken 48 h after the procedure) was given to Table 3. LA pressure was significantly reduced after PTMC measured during the procedure (27.5 ± 4.8 vs. 13.4 ± 3.0 mmHg, $p < 0.001$). MVA increased significantly (0.69 ± 0.13 vs. $1.6 \pm 0.21 \text{ cm}^2$, $p < 0.001$) and mean MV gradient (16.8 ± 3.5 vs. 4.4 ± 1 mmHg, $p < 0.001$) and pulmonary artery systolic pressure (PASP) measured by echocardiography on second post procedural day (62.8 ± 14.0 vs. 41 ± 8.2 mmHg, $p < 0.001$) decreased significantly after PTMC.

4. Complications

Vascular site minor complication was found in 5 % of cases. There was no procedural mortality, pericardial tamponade, or LV perforation. No incidence of acute MR requiring emergency mitral valve replacement. MR was increased by one grade in 4 (5 %) cases and two grades in 1 patient. Premature ventricular ectopic and the short run of ventricular tachycardia developed in 100 % cases, and which were haemodynamically non-significant, terminated immediately without any intervention.

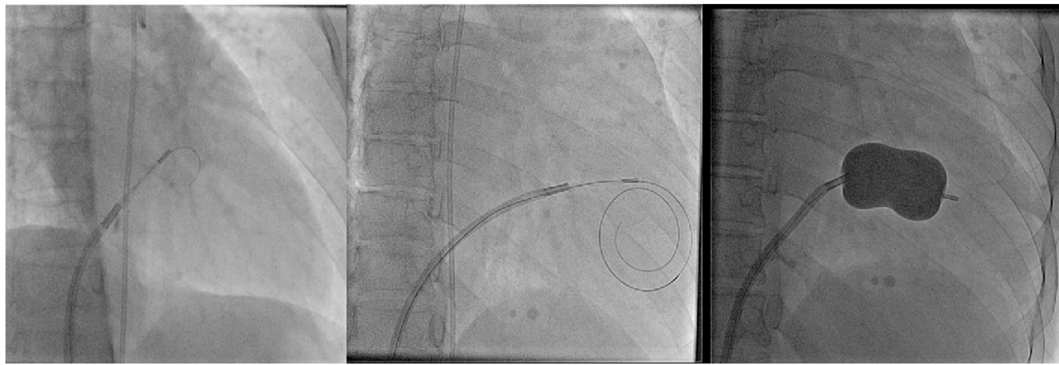


Fig. 2. Strategy 1- a. After initial failure, the J tip stylet was removed from the balloon, and Inoue Spring wire was taken and protruding through the tip of the balloon, b. Spring wire was pushed across the MV during diastole, and then the balloon was pushed into the LV over the wire c. Balloon inflation.



Fig. 3. Strategy 2- a. After initial failure, the balloon was removed, keeping the Inoue spring wire in LA, and then Mullin's sheath was introduced over the wire b. The Spring wire was pushed across the MV, and the Mullin's sheath was removed, c. Then the balloon negotiated over the wire, d. The balloon was pushed in the LV over the wire, e. The balloon was inflated.

Table 1
Baseline characteristics.

Parameters	
Age (mean ± SD)	30 ± 12 years
Male n(%)	30 (37.5 %)
Female n(%)	50 (62.5 %)
Mean MV area	0.69 ± 0.13 cm ²
Mean MV gradient	16.8 ± 3.5 mmHg
Mean Wilkin's score	8.1 ± 0.8
Mild mitral regurgitation	20(25 %)
Atrial fibrillation	34 (42.5 %)

Table 2
Causes of difficulties to enter the LV with standard technique.

Character	Patients no(%)
Critical MS	25 (31 %)
Giant LA (diameter >55 mm)	24 (30 %)
Low septal puncture	15 (19 %)
Thickened septum	8 (10 %)
Non specified	8 (10 %)

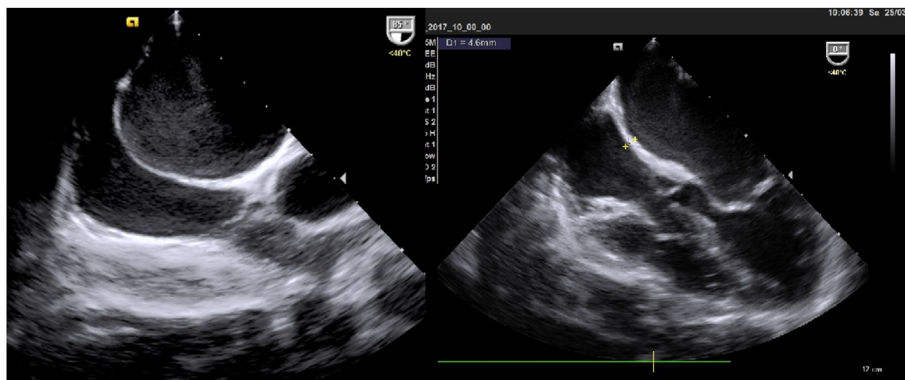


Fig. 4. Causes of difficulties to enter the LV a. Giant LA produced a considerable bulge responsible for an abnormal puncture, b. Thickened interatrial septum.

Table 3
Comparison of pre and post PTMC variables.

Parameter	Pre PTMC	Post PTMC	P value
Catheterization data			
LA mean pressure (mmHg)	27.5 ± 4.8	13.4 ± 3.0	<0.001
Echocardiographic data			
MVA (cm ²)	0.69 ± 0.13	1.6 ± 0.21	<0.001
MV mean gradient (mmHg)	16.8 ± 3.5	4.4 ± 1	<0.001
PASP (mmHg)	62.8 ± 14.0	41 ± 8.2	<0.001

5. Discussion

Since its introduction in 1984, the Inoue technique is the method of choice for PTMC worldwide through several modifications have been done. It is a relatively efficient and straight forward nonsurgical method of treating mitral stenosis with suitable anatomy. The success rate depends upon the operator's experience and how frequently the operator performs the procedure. Here 80 cases of PTMC were taken where we had to modify the standard technique of crossing the mitral valve by the Inoue balloon. We used two over-the-wire strategies to enter the LV as described above. Strategy 1 is successful in 31 % of cases, and in the remaining cases strategy 2 was applied. The overall success rate is 95 %. Modifying the LA graphy in RAO view, which visualizes the MV orifice, also decreases the overall rate of facing difficulties entering the LV from 21 % to 9 %.

PTMC procedure needs a long learning curve. As mentioned earlier, the failure rate ranges from 1 % to 17 %, with most failures occur early in the investigator's experience. Failure is due to the inability to puncture the atrial septum or to crossing the balloon correctly across the MV. Failures can also result from unfavourable anatomies, such as predominant subvalvular stenosis. Among them, failure to cross the mitral valve is the most common. In cases of tight MS, long-standing high LA pressure leads to gross LA enlargement, stretching, and thinning of the IAS, leading to gross IAS bulge. In this situation, the Brocken borough needle tends to slide upward along the septum resulting in either failure of IAS puncture or puncture at the wrong sites (low or high puncture/perforation of the atrial roof or aortic root). In addition, a puncture in the lower and anterior septum produces difficulties to cross the valve with the balloon catheter. Therefore, many modifications are advised in this situation: 1. Loop technique described by Inoue himself 1993²¹ 2. Cross the valve with balloon floatation catheter then insert the Inoue spring guidewire and introduce balloon as described by Mehan and Meier,¹⁹ 3. Redo puncture in a higher and more posterior position, 4. Straight balloon technique as described

by Patel et al.²² 5. Over the wire technique described by Meier with the help of 0.020 J tip wire and right Judkins catheter¹⁸ 6. Over the wire technique used by CN Manjunath and his team²⁰ with Mullin's sheath and spring wire. Here we took two over-the-wire strategies to cross the valve.

Critical MS, giant LA size, and low septal puncture were the three most common causes of failure to cross the valve. Manjunath et al. also found critical MS and abnormal puncture due to gross bulge of interatrial septum were the most common causes. In other studies 18, 22 larger atrium and non-ideal puncture sites such as upwards (cephaloid), leftwards (closure to mitral valve), and very low puncture are the significant causes of failure to cross the MV in conventional methods.

Our over-the-wire strategies are quite simple, need no extra instruments with a high success rate of 95 %. Strategy 1 was not reported previously in any studies and is quite simple, needs less procedural and fluoroscopic time compared to strategy 2. Our strategy 2 is like that of Manjunath et al., and their success rate was 93.75 %. Strategy 1 was preferred and was applied to all, and when unsuccessful strategy 2 was taken.

Compared with the above methods, our simplified techniques did not involve any additional accessories such as back-up guide wires, right Judkin's catheter, or balloon floatation catheters. Thus, additional expenses were avoided. Previous over-the-wire techniques described by Meier¹⁸ and Dani SI et al.²³ require multiple exchanges of wire and catheter. Our strategy 1 required no exchange, and strategy 2 required one exchange of Mullin's sheath once to introduce the balloon over the spring wire. Thus, the procedural time was reduced. Though the procedure time and the fluoro time were more than our average time required for doing PTMC, it included the time required for initial triage.

Another modification was done in the last 205 cases where the LA graphy was taken in the RAO view. We enter the LV in the RAO view. The LA graphy was taken in AP view by convention, and then we shifted to the RAO for MV crossing. So, the MV orifice visualized during the AP view did not match the RAO view. If we take the LA graphy in the RAO, it will demonstrate the MV orifice, which will help to cross the MV. This may explain the decreased rate of facing difficulties to cross the MV from 21 % to 9 %.

All parameters of successful PTMC are significantly different in pre and post PTMC. The echocardiographic data are taken on the second post-procedural day for giving time to change the LA compliance. PASP, though significantly different, needs time to settle down and will be reduced further on subsequent follow-up. No significant complications developed except ventricular ectopic and short-run VT in 100 % of terminated cases without any intervention.

6. Limitation of the study

Loop method to enter the LV is an alternative method but not tried in our cases as we are not familiar with it.

7. Conclusion

PTMC is the treatment of choice in a suitable case of severe rheumatic MS as long-term results are comparable to that of surgical counterparts. In difficult situations, modification of the standard Inoue technique requires for successful PTMC. Over-the-wire strategies to cross the MV to enter the LV is an attractive alteration of the standard technique, which is easy and requires no extra equipment. LA graphy in the RAO view reduces the frequency of these difficulties by visualizing the MV orifice.

What is already known?

Inoue balloon technique, along with few modifications, is the most used method for PTMC worldwide.

What does this study add?

In PTMC cases where LV entry is challenging, modification of Inoue technique with two over-the-wire strategies and taking the LA graphy in RAO view will increase the success rate.

Declaration of competing interest

None.

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