Popping-Out of an Inoue Balloon Catheter
— A Rare Sign of a Severe Subvalvular Mitral Lesion —

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Percutaneous transvenous mitral commissurotomy (PTMC) is an accepted and preferred therapeutic modality in selected patients with rheumatic mitral stenosis, and results in an encouraging long-term outcome. The Inoue single balloon method is a popular method of PTMC because it is technically less demanding. The geometry and fast inflation-deflation cycle of the balloon facilitate its advancement and positioning across the mitral valve. However, severe mitral subvalvular lesions are not uncommon and are associated with suboptimal PTMC results and a poorer long-term prognosis. As reported in the literature, the severe subvalvular lesions are characterized by signs of difficulty in performing the accordion maneuver, which is used to make sure the balloon catheter is not entrapped in subvalvular lesion, gross indentation of the inflated distal balloon, balloon impasse, cog-wheel resistance, initial inflation of the proximal balloon, or balloon rupture during PTMC. The abnormal indentations and subvalvular inflations may lead to rupture of mitral leaflets, chordae tendineae or papillary muscles and result in severe mitral regurgitation. In this case report, however, in the absence of the signs just described, we present new signs of a severe subvalvular lesion in a patient with severe mitral stenosis and a severe subvalvular lesion in whom the PTMC balloon catheter popped out into the left atrium during the late phase of balloon inflation.

Case Report

A 44-year-old woman, who had received an open mitral commissurotomy for mitral stenosis in March, 1980, was admitted for PTMC because of restenosis of the mitral valve. Echocardiographic examination showed severe mitral stenosis and mild mitral regurgitation with a mitral valve area of 0.82 cm² (CW Doppler). There was a severe subvalvular lesion with a marked calcification and fusion of the chordae tendineae and papillary muscles of the posterior mitral leaflet (Fig 1A). Although the mobility of the anterior leaflet of the mitral valve was fair, the M-mode echocardiogram and the short axis view of the leaflets of the mitral valve showed that the stenosis resulted from the fusion of the mitral commissures (Fig 1B-1C). After giving informed consent, diagnostic catheterization and PTMC using a 24-mm balloon catheter, which was one size smaller than the balloon reference sizing formula recommended, were performed as previously described. A marked subvalvular lesion was also seen on the left ventriculogram (Fig 1D). The mean left atrial pressure was 32 mmHg with a mean mitral diastolic pressure gradient of 16 mmHg. The PTMC was started with a balloon diameter of 21 mm. Manipulation of the balloon catheter to flow across the stenotic mitral valve into the left ventricle was smooth and unimpeded. The distal balloon was inflated and the catheter moved freely in the left ventricle (Fig 2A). The catheter was then pulled back to anchor the balloon at the stenotic mitral valve (Fig 2B). As the proximal balloon was being inflated, the distal one was levered upwards, especially in the systolic phase (Fig 2C). At the end of full inflation, the balloon catheter was expelled back into the left atrium (Fig 2D). The balloon size was then increased to 22 mm and the subsequent inflation was uneventful until the balloon catheter popped out near the end of inflation (Fig 3A-D). As the balloon size increased, the balloon catheter popped out more quickly and more forcefully (Fig 3D). A total of 5 trials of dilatation were performed with a final balloon diameter of 23 mm. Each attempt at balloon dilatation ended up with the catheter popping back into the left atrium, even though we advanced the distal segment of the catheter shaft slightly after the balloon attained its hourglass configuration. The PTMC was terminated when the post-inflation auscultation revealed a louder murmur of mitral regurgitation. The mean left atrial pressure remained at 32 mmHg with no change in the mean mitral diastolic pressure gradient. A repeat left ventriculography showed that the mitral regurgitation had increased from 1+ to 2+.

Discussion

When the stenotic mitral valve is enlarged by dilatations, the balloon might occasionally pop back into the left atrium during subsequent dilatations using larger balloon diame-
Fig 1. Severe subvalvular mitral lesion with calcification and fusion of the posterior mitral leaflet, chordae tendineae and papillary muscle (arrowheads) on the apical 4-chamber view of the two-dimensional echocardiography (Panel A). The M-mode echocardiogram and the short axis view of the leaflets of the mitral valve showed that the stenosis resulted from the fusion of the mitral commissures (Panels B and C). The severe subvalvular mitral lesion could also be seen on the left ventriculogram in a 30° right anterior oblique projection (Panel D).

Fig 2. Balloon inflation during balloon commissurotomy (21 mm in diameter). Panel A: The balloon catheter moved freely in the left ventricle. Panel B: The balloon catheter was pulled back and anchored at the mitral valve. Panel C: The distal balloon was levered up as the proximal one was being inflated. Panel D: The balloon catheter was expelled back into the left atrium at the end of balloon inflation.

Fig 3. Balloon inflation during balloon commissurotomy (22 mm in diameter). After inflation of the distal balloon, the balloon catheter was pulled back and anchored at the mitral valve (Panel A). The distal balloon was levered up during inflation of the proximal one (Panels B and C). The balloon catheter popped out of the left ventricle quickly and forcefully (Panel D).
ters. This balloon ‘popping’ signals enlargement of the mitral orifice and is usually encountered in patients with pliable and noncalcified valves. It indicates excellent PTMC results. In this case report, however, we have shown that lifting-up of the distal balloon during inflation of the proximal one and popping-out of the balloon catheter near the end of full inflation can occur in a patient with a severe subvalvular mitral lesion and results in a poor PTMC result.

In the Inoue balloon catheter, the intraballoon pressure shifts from a ‘low-pressure’ status to a ‘high-pressure’ one as the balloon is inflated to within 2 mm of its normal size (eg 22–24 mm in a 24-mm balloon catheter). In the present case, when the intraballoon pressure was low (21 mm in diameter), it was expelled at the end of inflation. When the intraballoon pressure was raised (22 and 23 mm in diameter), the balloon catheter popped out. We speculate that once the intraballoon pressure reaches a critical level, the highly fibrotic nature of the subvalvular apparatus prevents it from giving in to the dilating force of the balloon and instead makes the balloon catheter pop back into the left atrium.

The subvalvular mitral lesion in the patient reported here was mainly confined to the apparatus of the posterior leaflet. As demonstrated in Fig 1, the leaflet, chordae tendineae and the papillary muscle were calcified and fused into a round mass, so that the balloon catheter could not be entrapped in the mitral apparatus (balloon impasse). Because the anterior mitral leaflet was not as rigid as the posterior one and its mobility remained fair (Fig 1), the distal balloon was not compressed or indented, but rather was levered up during inflation of the balloon catheter when the waist of the balloon anchored at the stenotic valve and the proximal balloon was inflated.

In cases of severe subvalvular mitral lesion with signs of balloon impasse during PTMC, Lau and Hung recommended using a smaller Inoue balloon catheter of 18 or 20 mm in diameter (not commercially available in Taiwan) to avoid balloon impasse and prevent the creation of severe mitral regurgitation. We do not know whether this alternative method would be suitable in our patient, however, because it was easy for the balloon catheter to cross the mitral valve and there were no concerns about avulsion of subvalvular structures. In addition, using high intraballoon-pressure inflation of a smaller balloon catheter is unlikely to prevent the popping-out.

Conclusion

Levering-up of the distal balloon or popping-out of the balloon catheter during the inflation may be signs of severe subvalvular mitral lesions and demands more caution during PTMC.

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References