Case reports

Trefoil balloon for aortic valvuloplasty

BERNHARD MEIER, BEAT FRIEDLI, INGRID OBERHÄNSLI

From the Centre of Cardiology and the Department of Paediatrics, University Hospital, Geneva, Switzerland

SUMMARY A new balloon for valvuloplasty (Trefoil balloon) was successfully used in a 12 year old boy with congenital aortic stenosis. The Trefoil balloon consists of three angioplasty balloons mounted in parallel on a single shaft. When they are inflated simultaneously they produce a rosette that allows blood flow to continue through the valve. The aortic pressure only dropped to 75 mm Hg during a 15 s balloon dilatation at 4 bar (400 kPa). The procedure reduced the transvalvar gradient from 45 to 15 mm Hg.

Transluminal aortic valvuloplasty was first described in 1984.¹ To avoid a complete circulatory arrest when the balloon is blocking the valve, the creation of a left ventricular-venous shunt by connection of the central lumen of the balloon catheter to a venous catheter was recommended. The efficacy of this measure was not documented.

The balloon design presented here (Trefoil balloon, Schneider Medintag, Zurich, Switzerland) allows blood flow through the valve to continue during the dilatation process. The Trefoil balloon consists of three identical angioplasty balloons (modified polyvinyl chloride) mounted in parallel on a quadruple lumen catheter. The balloons are filled and emptied simultaneously through a single port. When they are inflated their cross section is that of a rosette or trefoil, which leaves space for blood flow. The diameter of the three balloons is selected according to the diameter of the valve annulus. The length of the balloons ranges from 20 to 45 mm and their waists are slightly tapered to secure their position in the valve. In the aorta and aortic valve of four dogs an oversized Trefoil balloon produced pressure gradients from 5 to 40 mm Hg when it was filled at 2-4 bar (200-400 kPa), whereas a conventional single balloon of comparable size produced complete occlusion.

Case report

A 12 year old boy (166 cm and 57 kg) with congenital

aortic stenosis complained of episodes of faintness and chest pain during exercise. The electrocardiogram showed pronounced left ventricular hyper-

Fig 1 Simultaneous left ventricular and aortic pressure recordings before, during, and after Trefoil balloon aortic valvuloplasty. The transvalvar pressure gradient was reduced from 45 mm Hg (left hand panel) to 15 mm Hg (right hand panel). During a 15 s balloon filling at 4 bar (400 kPa) the systolic aortic pressure remained at 75 mm Hg and the transvalvar pressure gradient was 80 mm Hg (middle panel).

Requests for reprints to Dr Bernhard Meier, Centre for Cardiology, University Hospital, 1211 Geneva 4, Switzerland.

Fig 2 Trefoil balloon (3×10 mm, length 40 mm) filled at 4 bar (400 kPa) in the aortic valve of the 12 year old boy. The measured total balloon diameter in this posteroanterior projection is 18 mm.

trophy. Cross sectional and Doppler echocardiography showed a competent but stenotic aortic valve with three cusps and a gradient of about 50 mm Hg.² The diameter of the annulus was assessed to be 20 mm. Cardiac catheterisation, which was performed under heavy sedation because the patient was very agitated, confirmed the diagnoses and showed a peak to peak aortic valvar gradient of 60 mm Hg.

Aortic valvuloplasty was performed a few weeks later under general anaesthesia. The peak to peak gradient measured 45 mm Hg (fig 1). A 3×10 mm Trefoil balloon with a 9 French shaft, length 40 mm, with a maximal circumference corresponding to a 19.4 mm single balloon was selected.

First, a 0.038 inch (1 mm) exchange wire was inserted into the right femoral artery by means of the Seldinger technique. It was placed in the left ventricle through a pigtail catheter. After dilatation of the puncture site with an 11 French dilator the balloon catheter was introduced and advanced into the left ventricle. It was deemed necessary to leave a wire protruding from the rigid balloon tip to avoid injury of the left ventricular wall. From animal experiments we knew that the balloon moves vigorously up and down during the filling period until it is engaged in the valve. To facilitate left ventricular pressure recordings through the central lumen of the balloon catheter, a 0.032 inch (0.8 mm) wire was substituted

for the 0.038 inch (1 mm) wire. For simultaneous recording of the aortic pressure, a pigtail catheter was advanced into the aortic arch through the opposite femoral artery. Four balloon fillings at 4 bar (400 kPa) for 5 to 15 s were performed; during these the aortic pressure did not drop below 75 mm Hg (fig 1). The residual peak to peak transvalvar pressure gradient was 15 mm Hg (fig 1). A final aortic root injection showed only minimal aortic regurgitation. Figure 2 shows the filled balloon in place.

The catheters were withdrawn and manual pressure was applied for 20 min. Inguinal bleeding occurred when the patient woke up and became agitated despite the application of a pressure dressing. Additional pressure was applied and two units of red blood cells were given. The next day a systolic ejection murmur was still present on auscultation but there was no diastolic murmur. Echocardiography showed a residual gradient of 15 to 20 mm Hg and a minimal aortic regurgitation. The patient was discharged from the hospital the day after the procedure.

Discussion

Percutaneous aortic valvuloplasty with a Trefoil balloon did not lead to the circulatory collapse known to be associated with balloon valvuloplasty. The blood flow through the creases between the three balloons was sufficient in this case of only moderate aortic stenosis to maintain the systemic pressure during a 15 s dilatation manoeuvre at a level that was adequate for the vital organs. It is conceivable that in a very tight valve the flow will be minimal or absent until the balloon has unfolded to a certain extent. Further experience with Trefoil balloon valvuloplasty in aortic, pulmonary, and mitral valve stenosis will show whether the results with this new type of balloon are comparable to those of valvuloplasty with conventional single balloons. The applicability of the Trefoil balloon to complicated or routine coronary angioplasty is currently under investigation.

References

- 1 Lababidi Z, Wu JR, Walls JT. Percutaneous balloon aortic valvuloplasty: results in 23 patients. *Am J Cardiol* 1984;53:194-7.
- 2 Hatle L, Angelsen B. *Doppler ultrasound in cardiology*. 2nd ed. Philadelphia: Lea and Febiger, 1985:22-6.