CASE REPORT

Percutaneous balloon pulmonary valvuloplasty (PBPV) of extreme pulmonary valve stenosis by the use of Accura balloon

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Accepted 28 August 2017

SUMMARY

Transcatheter therapy of valvular pulmonary stenosis is one of first catheter interventions facilitating its application in field of structural heart disease and now treatment of choice for significant pulmonary stenosis. Myriads of balloon catheter have been used for this purpose starting from Diamond (Boston Scientific, Natick, MA USA), Marshal (Medi-Tech, Watertown MA USA), Inoue balloon, Tyshak I and currently Tyshak II. Diameter and length of balloon depend on size of annulus and age group, respectively. Problem with shorter balloon is difficulty in keeping it across the annulus while inflation as it tends to slip distally whereas with longer balloon, potential of tricuspid leak or conduction block as it may impinge on adjacent structures. Potential advantage of Accura balloon over Tyshak balloon lies in its peculiar shape while inflation and variable diameter, making stepwise dilatation possible. Here, we report a case of successful balloon pulmonary valvuloplasty using Accura balloon (Vascular Concept, UK) with little modification of conventional technique.

BACKGROUND

With the available balloon catheters for percutaneous balloon pulmonary valvuloplasty (PBPV) because of their fixed size and over-the-wire design, procedure will require one or may be two balloons depending on size of the annulus. Inherent problems with these balloons are balloon slippage (watermelon seeding) and prolong inflation and deflation time, sometime causing bradycardia and hypotension thus making patient haemodynamically unstable. Furthermore, longer balloon may cause tricuspid leak or conduction block as it may impinge on adjacent structures. These limitations were circumvented using an Accura percutaneous mitral valvulotomy balloon as it is shorter in length and has relatively shorter deflation time causing faster haemodynamic recovery. Moreover, it has a unique property of self-positioning which enables it to anchor at the pulmonary annulus, thus negates the watermelon seeding effect. It can also be advanced over the super stiff Amplatz guide-wire (0.035 inch), thus facilitating the procedure in patients with extreme pulmonary valve stenosis where gradient is very high. Although PBPV has been successfully reported with Inoue balloon, to the best of our knowledge, this is the first report of successful PBPV with Accura balloon.

CASE PRESENTATION

A 15-year-old boy was presented with exertional dyspnoea, palpitation and fatigue for last 3 years which had progressed to New York Heart Association class III. On clinical examination, his vitals were stable. On palpation, there was grade II right parasternal heave and thrill in second and third left intercostal space. On auscultation, S1 was soft; S2 was soft with delayed, soft P2 component, ejection click and prolonged grade 4/6 ejection systolic murmur best heard in second and third left intercostal space.

INVESTIGATIONS

ECG showed normal sinus rhythm, right axis deviation, evidence of right ventricular hypertrophy (RV) with ST-T changes in precordial leads. Chest X-ray posteroanterior view showed normal cardiac size, RV type of apex and poststenotic dilatation of pulmonary artery (PA). His routine haemogram were within normal limits. Two-dimensional transthoracic echocardiography in apical four-chamber view showed dilated right atrium (RA), RV and severe tricuspid regurgitation (TR) with TR velocity of 6.6 m/s. Parasternal short axis view showed thickened and doming of the pulmonary valve with peak instantaneous gradient of 175 mm Hg across the pulmonary valve. Right femoral vein was accessed with 5F sheath under local anaesthesia and 3000 U of unfractionated heparin was administered. On cardiac catheterisation, RV angiogram in left lateral view revealed doming of valves, severe valvular pulmonary stenosis with annulus measuring 20 mm by quantitative coronary analysis (figure 1A). RV peak systolic pressure was 178 mm Hg, mean RA pressure was 16 mm Hg and PA peak systolic pressure was 19 mm Hg, thereby peak-to peak gradient across the pulmonary valve of 160 mm Hg (figure 2A, B).

DIFFERENTIAL DIAGNOSIS

In our case, it was congenital pulmonary stenosis as supported by normal physical appearance, RV impulse that included third left intercostal space, ejection systolic murmur and thrill maximum in second and third left intercostal space, ejection click and delayed, soft P2 component of second heart sound, chest X-ray showing poststenotic dilatation and mobile dome-shaped valve identified on angiogram as well as echocardiogram. Dysplastic

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To cite: Sinha SK, Mishra V, Razi M, et al. *BMJ Case Rep* Published Online First: [please include Day Month Year]. doi:10.1136/bcr-2017-221533

Figure 1 (A) Right ventricular angiogram in left lateral view showing characteristic doming of the pulmonary valve. (B) Amplatz guidewire parked in left lower pulmonary artery. (C) Forward migration of balloon as waist is visible proximally instead appearing in middle. (D) Left atrial wire parked in left pulmonary artery.

pulmonary valve stenosis characteristically seen in patients with Noonan syndrome was excluded by the absence of distinctive physical appearance, ejection click and the presence of fixed, thickened and dysplastic cusps on echocardiogram. Subinfundibular stenosis is characterised by RV impulse confined to lower left sternal border or subxiphoid area, ejection systolic murmur below the third left intercostal space, the absence of ejection sound, nondilated pulmonary trunk and echocardiogram showing obstructive muscle bundle and Doppler flow turbulence within the RV which were absent in our case. Pulmonary artery stenosis is characterised by syndromic association, normal character and splitting of S2, widespread systolic murmur in axilla and back, and characteristic finding on catheter angiogram which was too excluded in our case.

TREATMENT

With informed consent from his guardian, PBPV was planned. The pulmonary valve was crossed with a 5F multi-purpose (MPA) catheter (Medtronic, USA) with help of

Figure 2 Right ventricular pressure (A—preprocedure; C—postprocedure) and pulmonary artery pressure (B—preprocedure; D—postpreprocedure). Peak-to-peak systolic pressure gradient before the procedure was 160 mm Hg (right ventricular systolic pressure (RVSP)—178 mm Hg, pulmonary artery systolic pressure (PASP)—19 mm Hg; red arrow) which came down to 18 mm Hg after the procedure (RVSP—64 mm Hg, PASP—48 mm Hg; green arrow).

Figure 3 (A) Accura balloon along with metal stretching tube being tracked over left atrial wire but it could not be negotiated from right atrium to right ventricle. (B) Accura balloon was slenderised by withdrawing the metal stretching tube.

0.035 inch terumo wire (Terumo, Japan). Terumo wire was then exchanged with 260 cm, 0.035 inch Amplatz superstiff long guidewire (Cordis, USA) which was parked in left lower PA branch and MPA catheter was withdrawn ([figure 1B](#)). 5F venous sheath was exchanged with 9F sheath. An over-the-wire 50×24 mm Tyshak II balloon was introduced through venous sheath and negotiated across the pulmonary valve. It was inflated with 50 mL syringe containing diluted contrast but it tend to slip forward ([figure 1C](#)). We did the same by keeping approximately proximal two-third of balloon in RV but again either slipped forward into PA or back into the RV outflow tract. On one occasion, it caused bradycardia and hypotension which was managed with injection atropine and intravenous fluid. We then decided to go with Accura Balloon Mitral Valvotomy (BMV) balloon (Vascular Concept, Essex, UK). Amplatz guidewire was exchanged with 0.025 inch left atrial (LA) stainless steel guidewire with putting its loop in left PA branch for better support ([figure 1D](#)). Venous sheath was withdrawn, local site dilated with 12F dilator to facilitate its entry and balloon pulmonary valvuloplasty attempted with Accura balloon but it could not be negotiated from RA to RV and rather looped wire tended to prolapsed into RV due to its poor support ([figure 3A](#)). Balloon was withdrawn and MPA catheter was tracked over the LA wire beyond the pulmonary valve. LA wire was exchanged with Amplatz superstiff wire and MPA was withdrawn. Procedure was reattempted with Accura balloon but we encountered the same difficulty while tracking it from RA to RV because balloon assembly was bulky, straight and therefore was unable to negotiate the curve from RA to RV. We then realised that the metal stretching tube inside the balloon was responsible for the hindrance. Therefore, once it reached RA, metal stretching tube inside the balloon was removed ([figure 3B](#)), thereby slenderising the balloon. It was gradually negotiated across the pulmonary valve with gentle clockwise turn and push. Once reached beyond the valve, it was partially inflated and withdrawn to put the waist across the valve and inflated to 24 mm, thereby achieving successful dilatation ([figure 4A](#)).

OUTCOME AND FOLLOW-UP

RV pressure came down to 64/6 mm Hg ([figure 2C](#)), PA pressure shoot to 46/10 mm Hg ([figure 2D](#)) and RA mean came down to 6 mm Hg after balloon dilatation, thereby gradient coming down to 18 mm Hg from 169 mm Hg. Local site was secured with z-knot. Patient was discharged in haemodynamically stable condition and is in regular follow-up since then.

Figure 4 Successful percutaneous balloon pulmonary valvuloplasty with Accura balloon over Amplatz wire.

DISCUSSION

Valvular pulmonary stenosis is mostly because of commissural fusion giving it a doming appearance or rarely dysplastic leaflets. Catheter-based treatment, first reported by Kan *et al* in 1982¹ has replaced surgical knife in case of commissural fusion because of high success rate, lower complication and excellent long-term safety both in paediatric and adult cohort compared with stenosis because of the dysplastic valve. Transcatheter-based treatment has used both single and double balloon, each having their limitations. In last decade, Tyshak II has become the choice for most of the operators because of its low profile and excellent trackability. Potential disadvantage with this balloon is fixed size, longer inflation and deflation time, forward slippage and sometimes, periprocedural haemodynamic instability though transient. Inoue BMV balloon have also been used as reported by Lau *et al*,² Patel *et al*³ and Bahl *et al*.⁴ In our case, balloon slippage and haemodynamic instability were the cause of failure with Tyshak II balloon. We could have used a double-balloon technique or rapid pacing to stabilise the balloon at the time of inflation but that would needed another contralateral venous access. In order to overcome these limitations, procedure was performed using Accura balloon. It has short cycle of positioning–inflation–deflation which gets completed within 5 s and therefore minimal haemodynamic instability and faster haemodynamic recovery if at all occurs. During course of inflation, it becomes balloon floatation catheter because of distal inflated portion, assumes a dog-bone shape when engaged across the valve and proximal part gets inflated. This imparts it perfect anchorage for the valve dilation negating any slippage either proximal or distal. During terminal inflation, shaft expands achieving perfect commissurotomy. At this time, procedure can be repeated depending on the need without disengaging the catheter. Slenderisation and modification of the standard technique, that is, using superstiff

Amplatz guidewire instead of stainless steel LA wire is similar to as reported by Patel *et al*⁵ but they had used Inoue balloon. Inoue and Accura balloons are although fundamentally similar, their pressure and volume relationship are different. Their size reflects the maximum diameter of the waist or middle part at the full inflation. Accura balloon has advantage over Inoue balloon that it can deliver more stable and higher pressure when inflated within standard diameter range, therefore better splitting of commissures at the same pressure compared with Inoue balloon. Furthermore, balloon size attainable with Inoue and Accura balloon is +4 and +3 mm, respectively. Our aim was to relieve the gradient and let the valve remodel with time because larger size attained with Inoue could have led to pulmonary regurgitation. Also, recommended contrast dilution with Inoue and Accura balloon is 1:4 and 1:6–8, respectively, which means that deflation time is lesser with Accura balloon. Haemodynamic instability was encountered in our case in lieu of critical stenosis, and therefore, Accura balloon scored over the Inoue balloon.

Learning points

- ▶ Percutaneous balloon pulmonary valvuloplasty (PBPV) is though safe with remarkably minimal complications, at times may be difficult.
- ▶ Balloon slippage (watermelon seeding) is very common phenomenon during balloon inflation.
- ▶ Prolong inflation and deflation of balloon sometime may cause bradycardia and hypotension though transient, thus making patient haemodynamically unstable.
- ▶ PBPV can be successfully done by using Accura balloon but needs to be slenderised by pulling metal stretching tube once it reaches right atrium to facilitate its delivery across the pulmonary valve over Amplatz superstiff guidewire.
- ▶ This technique may be useful during PBPV in patient with extreme pulmonary valve stenosis when conventional option fails.

Contributors SKS: conception and design, acquisition of data or analysis and interpretation of data. VM: drafting the article or revising it critically for important intellectual content. MR: agreement to be accountable for the article and to ensure that all questions regarding the accuracy or integrity of the article are investigated and resolved. MJJ: final approval of the version published.

Competing interests None declared.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

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REFERENCES

- 1 Kan JS, White RI, Mitchell SE, *et al*. Percutaneous balloon valvuloplasty: a new method for treating congenital pulmonary-valve stenosis. *N Engl J Med* 1982;307:540–2.
- 2 Lau KW, Hung JS, Wu JJ, *et al*. Pulmonary valvuloplasty in adults using the Inoue balloon catheter. *Cathet Cardiovasc Diagn* 1993;29:99–104.
- 3 Patel TM, Dani SI, Shah SC, *et al*. Inoue-Balloon Pulmonary Valvuloplasty Using a ÒFree-FloatÓ Technique. *J Invasive Cardiol* 1996;8:374–7.
- 4 Bahl VK, Chandra S, Goel A, *et al*. Versatility of Inoue balloon catheter. *Int J Cardiol* 1997;59:75–83.
- 5 Deora S, Vyas C, Shah S, *et al*. Percutaneous balloon pulmonary valvuloplasty: a modified over-the-wire Inoue balloon technique for difficult right ventricular anatomy. *Indian Heart J* 2014;66:211–3.

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