Case Report

Cracking a Tricuspid Perimount Bioprosthesis to Optimize a Second Transcatheter Sapien Valve-in-Valve Placement

Stephen C. Brown,[1,2] MD, PhD, Bjorn Cools,[1] MD, and Marc Gewillig,[1*] MD

Bioprosthetic valves degenerate over time. Transcatheter valve-in-valve procedures have become an attractive alternative to surgery. However, every valve increasingly diminishes the diameter of the valvar orifice. We report a 12-year-old female who had a previous transcatheter tricuspid valve-in-valve procedure; cracking the ring of a Carpentier Edwards Perimount valve by means of an ultrahigh pressure balloon allowed implantation of a further larger percutaneous valve. The advantage of this novel approach permits enlarging the inner valve diameter and may facilitate future interventions and prolong time to surgery. © 2016 Wiley Periodicals, Inc.

Key words: valve-in-valve; cracking; ultrahigh pressure balloon; percutaneous

INTRODUCTION

Percutaneous valve-in-valve implantation of transcatheter valves in degenerated or dysfunctional bioprosthetic valves in the pulmonic, tricuspid, aortic, and mitral positions is now regarded as acceptable alternatives to surgery [1–4]. In the tricuspid position, the frame of a surgically implanted bioprosthesis usually provides adequate support for a percutaneous valve. However, the effective inner diameter of the orifice of a surgically implanted valve is smaller than the external valve dimension. During a valve-in-valve implantation, this diameter is further decreased, limiting the options for satisfactory future transcatheter treatment. We report a case who had a previous transcatheter tricuspid valve-in-valve procedure where the Carpentier Edwards Perimount® valve ring (Edwards Life sciences, Irvine, CA) was cracked before implantation of a second percutaneous Sapien valve.

CASE REPORT

The patient, a 12-year-old female with a weight of 55 kg and height of 1.63 m, had several procedures during childhood. She presented in infancy with multiple large ventricular septal defects (VSD) and required a pulmonary artery banding shortly after birth. The VSD's were subsequently closed with primary suture, patch closure and one Amplatzer PFO device (St. Jude Medical, Minnesota). The right ventricular disc of the device resulted in transection of some tricuspid valve chordae. She developed severe tricuspid regurgitation due to a flail leaflet; attempted repair failed and a 25 mm Carpentier Edwards Perimount valve was surgically inserted in 2004 at the age of 3 years. A

[1]Fetal and Pediatric Cardiology, University Hospitals Leuven, Belgium
[2]Pediatric Cardiology, University of the Free State, South Africa

Institution at which work was performed: University Hospitals Leuven, Herestraat 49, B 3000, Leuven, Belgium

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*Correspondence to: Marc Gewillig, University Hospital Gasthuisberg, Herestraat 49, B 3000 Leuven, Belgium. E-mail: marc.gewillig@uzleuven.be

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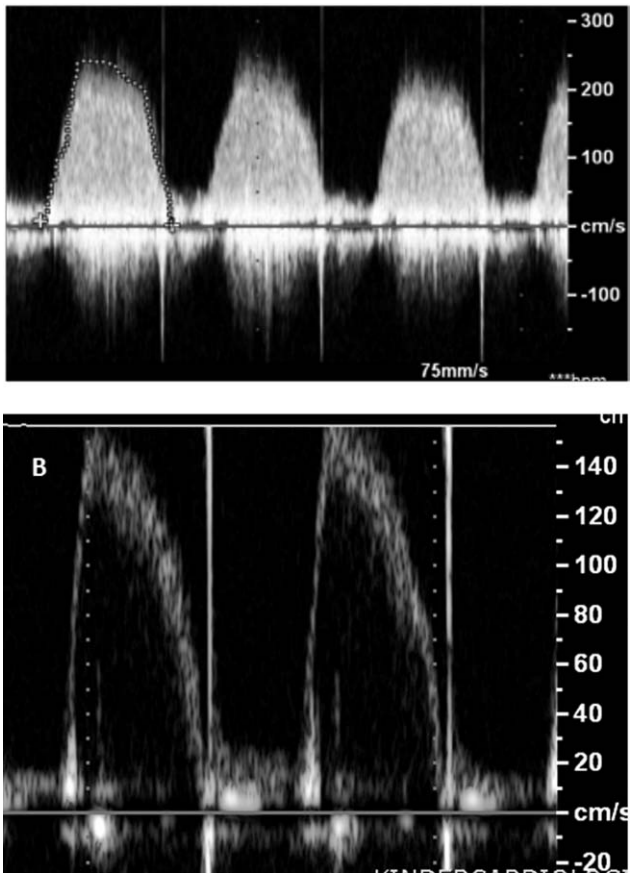

Fig. 1. Tricuspid valve stenosis. (A) Continuous wave Doppler tracing shows high peak flow with a mean gradient of 13 mm Hg over the original valve-in-valve assembly pre-implantation of second valve-in-valve. (B) Pulsed wave Doppler tracing following second valve-in-valve implantation demonstrates markedly reduced peak flow.

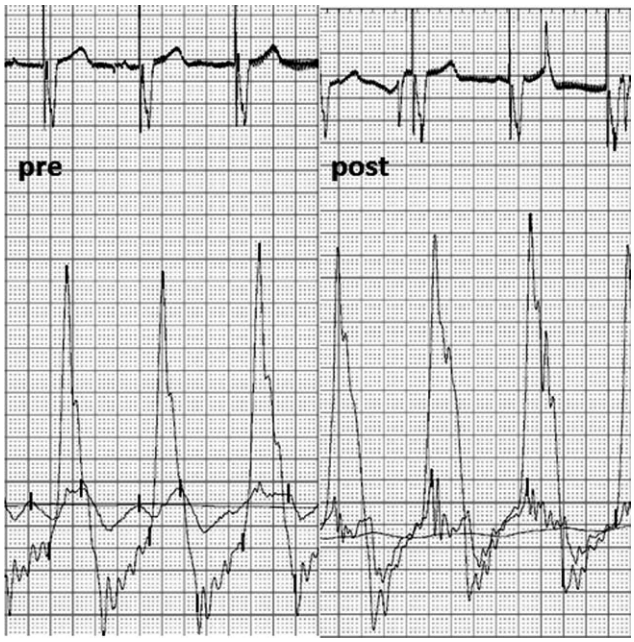

Fig. 2. Tricuspid valve stenosis. Pressure tracings pre and post second valve-in-valve implantation

permanent pacemaker due to acquired complete atrioventricular block was also required.

Six years later, she presented with marked tricuspid valve regurgitation and stenosis. A 26 mm Sapien XT valve was percutaneously implanted at that stage within the perimount valve: it opened from 21 mm in the ring up to 25 mm at the right ventricular (RV) end. This procedure was extensively described in a previous publication [5].

In 2015, she became symptomatic with ascites and signs of right heart failure. Echocardiography revealed the cause as tricuspid stenosis with a mean gradient of 13 mm Hg across the tricuspid valve (Figs. 1 and 2). The interatrial septum was also bulging towards the left atrium.

The patient was brought to the catheterization laboratory and jugular venous access obtained. Balloon-interrogation by means of a 23 mm Tyshak® balloon (NuMED, Hopkinton, NY) was first carried out. This indicated a diameter of 20.7 mm on the frontal fluoroscopic image. This had no effect on the Trans esophageal (TEE) and catheter derived tricuspid valve gradients. We decided to enlarge the valve orifice by cracking the valve ring of the previously implanted bioprosthesis. A 26 mm Atlas Gold balloon® (Bard, PV, Europe) was inflated to 18 ATM (atmospheres) and inflation was stopped when cracking was observed on fluoroscopy and an audible popping noise was heard (Fig 3, Supporting Information). Due to the fact that gradient remained unchanged, a second 26 mm Sapien XT valve was percutaneously implanted via jugular route during rapid pacing with full inflation up to 26 mm (Fig 4). All gradients were abolished and the patient was discharged 48 hours later. The jugular venous access was managed by reversal of heparin and one Donati-type suture (removed after 7 days) as well as mild local compression until after extubation [6].

DISCUSSION

This case is unique since it represents one of very few reports where a second percutaneous valve has been implanted in a previously implanted percutaneous valve in a bioprosthetic valve. Furthermore, it demonstrates that controlled cracking of a perimount valve can be safely performed.

Cracking the ring of a perimount bioprosthesis with ultrahigh pressure balloons was first described by Tanase et al. [7]. They demonstrated that the elastic properties of the Elgiloy Polyester band of the valve is maintained resulting in predictable expansion as well

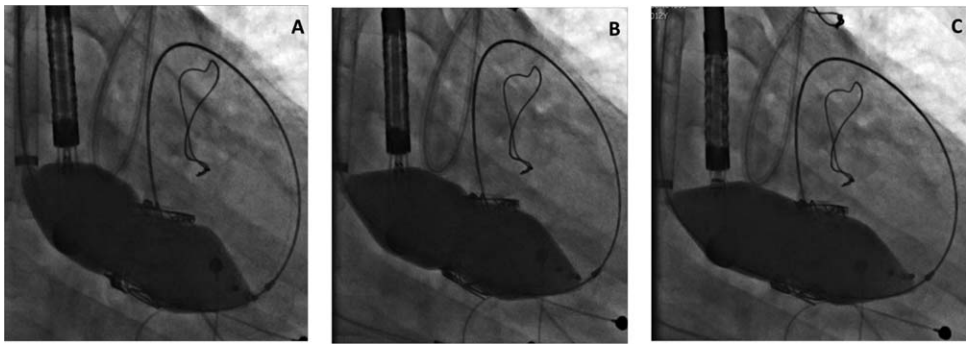

Fig. 3. Cracking of Perimount bioprosthesis. Sequential inflation of 26 mm Atlas Gold balloon up to 18 ATM. (A) Initial inflation with indentation at valve ring. (B) Midway during inflation, waist still present in balloon. (C) Fracture of valve ring – full expansion accompanied by audible "crack" (Supporting Information).

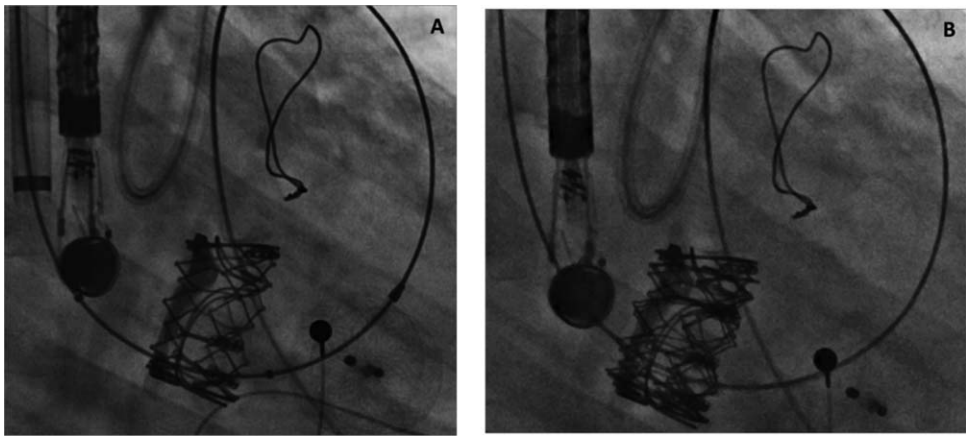

Fig. 4. Angiographic appearance of valve assembly. (A) Before implantation of second valve-in-valve. (B) After second valve. Note expansion of valve ring and overlapping of struts of stented valve. The thickened cusps of previous valves probably responsible for larger distal diameter of assembly.

as allowing the ring to maintain its circular shape. This provides an explanation for the fact that the gradient over the valve remained unchanged in our patient after cracking the ring and that subsequent implantation of a second transcatheter valve was successful since it could be expanded to the desired diameter and the valve-in-valve assembly gave rise to adequate radial strength. Using the correct ultrahigh pressure balloon is important since the woven polyethylene fibers in these specialized balloons do not elongate and cause overexpansion at the ends, limiting the possibility of damage to adjacent vascular structures and ensures controlled radial expansion [8,9]. The authors also pointed out that these balloons can be inflated to a substantially higher pressure than the rated burst pressure – which is sometimes required to crack a valve ring (bench testing).

The advantages of cracking the ring in this patient are evident. Since the true inner diameter of a 25 mm perimount valve is 23 mm, and a transcatheter Sapien valve is at least 1 mm thick, the true inner diameter of the tricuspid valve in this child was less than 21 mm. Performing another valve-in-valve would have reduced this to a maximum of 19 mm. Cracking the ring thus allowed us to considerably enlarge the inner diameter of the valve (152% increase in surface of valve orifice) and theoretically allow further percutaneous interventions in the future. In addition, once the inner dimensions become problematic in the future, the surgeon can remove the percutaneous valves and use the original perimount to anchor and support a new tricuspid stent valve. It would probably have been better to crack the ring during the initial stented valve implantation as every additional stent may make the assembly stiffer and thus harder to crack.

The operator should however, be alert to complications. Over-stretching could result in tears, hemorrhage,

as well as pressure on the conduction tissues; our patient had a previously implanted pacemaker with epicardial leads. One should also be aware of calcifications, where breakage could lead to eccentric displacement of the surrounding tissue. This may lead to obstruction of a coronary artery or cause paravalvular leaks.

CONCLUSION

It is possible to fracture certain bioprosthesis using ultra-high pressure balloons; this may allow one to enlarge the orificial surface. This case demonstrates that by careful planning for future interventions and using novel techniques, surgery can be delayed and transcatheter valve implantations facilitated.

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