Clinical Case Reports

Open Access

CASE REPORT

Transcatheter CoreValve valve-in-valve implantation in a stentless porcine aortic valve for severe aortic regurgitation

Celina M. Yong, Maurice Buchbinder & John C. Giacomini

Stanford University/VA Palo Alto Healthcare System, Palo Alto, California

Correspondence
John Giacomini, Division of Cardiovascular Medicine, Stanford University, Chief, Cardiology Section, VA Palo Alto Health Care System, 111C Cardiology, 3801 Miranda Avenue, Palo Alto, CA 94305.
Tel: 650-493-5000;
Fax: 650 852 3473;
E-mail: giacomini@stanford.edu

Funding Information
The preparation of this manuscript was funded by the Palo Alto Veterans Institute for Research (PAVIR).

Received: 10 January 2014; Revised: 2 July 2014; Accepted: 6 July 2014

Clinical Case Reports **2014; 2(6): 281–285**

doi: 10.1002/ccr3.113

Key Clinical Message

We describe the first valve-in-valve Corevalve transcatheter aortic valve replacement in the St. Jude Toronto stentless porcine aortic valve in the United States, which enabled this 59-year-old patient with a history of bacterial endocarditis and aortic regurgitation to avoid heart transplant with complete resolution of his severe left ventricular dysfunction.

Keywords

Aortic regurgitation, stentless valve, TAVR, valve-in-valve.

Background

While transcatheter aortic valve replacement (TAVR) volume has grown substantially worldwide in recent years, our collective experience with transcatheter valve-in-valve placement remains relatively low. The first percutaneous valve-in-valve procedure using the CoreValve Revalving system for aortic regurgitation in a Sorin Mitroflow aortic bioprosthesis was reported in 2007 in Germany [1]. Since then, other case reports of valve-in-valve procedures to treat a failing aortic valve bioprosthesis have been described, but very few in stentless bioprostheses [2]. The global valve-in-valve registry of 202 patients (mean age 78 years, 53% men) includes 124 CoreValve and 78 Edwards Sapien valves placed in degenerated bioprosthetic valves for aortic stenosis and/or regurgitation [3]. Adverse procedural outcomes included initial device malposition in 15% of cases and ostial coronary obstruction in 4% of cases. At 30-day follow-up, mortality was 8%. Results from a series of 27 cases in Germany suggest that transfemoral valve-in-valve implantation, regardless of the failure mode of the original valve, is a feasible and safe option even in older, higher risk patients [4]. Similar results from smaller numbers of patients from another site in Germany [5] and from Israel [6] have also been reported. We report the first transcatheter CoreValve valve-in-valve implantation in a stentless porcine aortic valve in the United States for severe aortic regurgitation. The ensuing challenges we discuss have not been previously reported to our knowledge.

Case Report

In 1998, a 47-year-old man developed vague symptoms of shortness of breath and fever while on military service in Kuwait. He was diagnosed with and treated for bronchitis at the time. When he returned to the United States, he was evaluated with a transthoracic echocardiogram, which revealed mild aortic regurgitation. He was presumed to have had endocarditis and he was treated and followed up. In 2000, his symptoms worsened and he underwent aortic valve replacement with a St. Jude Toronto stentless

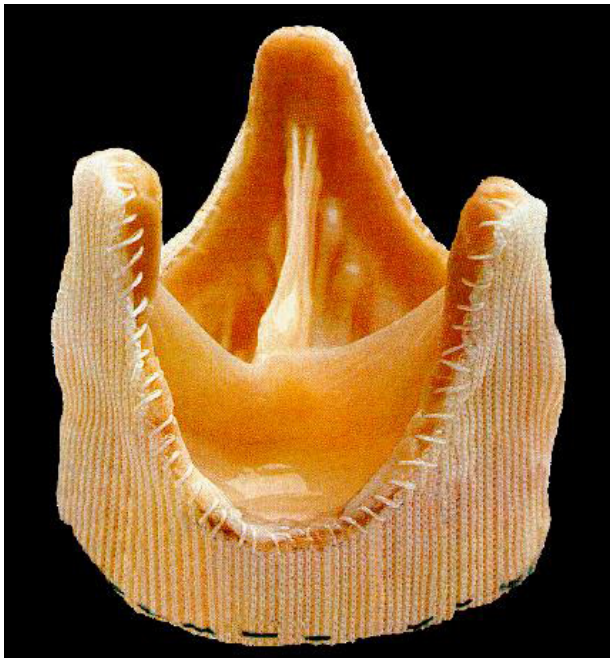

Figure 1. St. Jude toronto stentless porcine aortic valve. (Source: www.heartlungdoc.com).

porcine valve (Fig. 1). Despite his young age, he refused a mechanical valve prosthesis since he wished to avoid anticoagulation so he could continue active military duty. Shortly after the procedure, his symptoms resolved and then he was lost to follow-up.

He presented twelve years later in the Fall of 2012, at the age of 59, complaining of progressive exertional dyspnea and chest pain. Despite these symptoms, he was still able to exercise about two hours daily, but he noted that this was a substantial decline from his baseline. In December of 2012, he underwent repeat transthoracic echocardiogram, which showed a moderately thickened and calcified bioprosthetic aortic valve with severe regurgitation. He was scheduled for reoperation within a few months. Over the ensuing months, he developed worsening symptoms with orthopnea and lower extremity edema. Repeat transthoracic echocardiogram in April of 2013 showed a markedly dilated left ventricle with severe global hypokinesis and a left ventricular ejection fraction of 20%. He was admitted to the hospital for IV diuresis and inotropic support. He was gradually transitioned to his oral regimen of lisinopril, furosemide, and carvedilol. However, his severe physical decline and cardiomyopathy prompted consideration of heart transplant rather than redo aortic valve replacement.

He was transferred to our institution and evaluated by the heart transplant team, who deemed him an appropriate candidate for transplant. However, before listing, they consulted the interventional cardiology and cardiac surgery team regarding other possible options. Although it was unclear whether his left ventricular function would recover even after successful valve-in-valve TAVR, the interventional cardiology and cardiac surgery team counseled the patient regarding the possible risks and benefits. With the patient's consent, he was scheduled urgently for TAVR under a compassionate use protocol.

Pre-TAVR evaluation included a coronary angiogram, right heart catheterization, and CT of the Chest/Abdomen/Pelvis. The angiogram showed normal coronary arteries. Right heart catheterization showed a right atrial pressure of 6 mmHg, right ventricular pressure of 50/6 mmHg, and pulmonary arterial pressure of 50/26 mmHg with a mean of 34 mmHg. The Pulmonary Capillary Wedge Pressure (PCWP) was 27 mmHg, with a blood pressure of 90/50 mmHg, the cardiac output was 3.2 L/min and the cardiac index was 1.9. The pulmonary vascular resistance was 2.2 woods units and the systemic vascular resistance was 1700 dyn-s/cm^5.

CT showed an aortic annulus of 20.4 × 29.2 mm with a perimeter of 76.6 mm and an angle of 35.5° (Fig. 2). The sinuses of Valsalva measured 32.5, 33.5, and 35.3 mm at the noncoronary, left, and right coronary cusps, respectively. The ascending aorta measured 36.8 × 38.8 mm at a level 40 mm above the valve. The inner diameter of the previous stentless valve was 18.2 × 24.1 mm with an inner circumference of 67.4 mm. The distance from the valve to the right coronary ostium was 16 mm, and the distance from the valve to the left coronary ostium was 14.7 mm. The right coronary cusp was somewhat dilated and the left coronary cusp was asymmetric. Ilio-femoral arterial dimensions bilaterally were all greater than 8.3 mm, without significant calcification or tortuosity. Based on these measurements, a femoral approach was planned with the

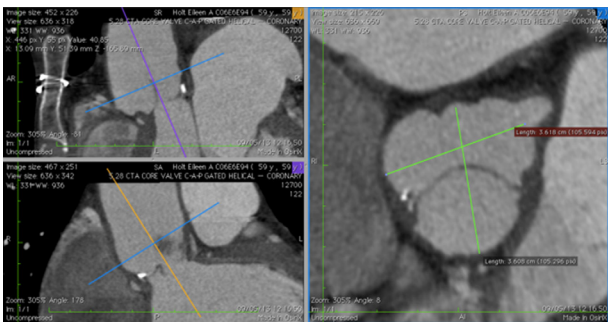

Figure 2. CT image of pre-TAVR stentless aortic valve in cross section.

anticipated use of either a 26 or 29 mm CoreValve prosthesis.

For the procedure, an 18F sheath was inserted via surgical cut down in the right femoral artery and the aortic valve was crossed with a 0.35 mm straight wire. A pigtail was advanced over the wire into the left ventricle and baseline hemodynamic measurements were performed. An exchange length pre-shaped Lunderquist wire was advanced against the left ventricular apex. After removal of the pigtail catheter, a 26 mm CoreValve prosthesis was passed and partially deployed (Fig. 3). Even with partial deployment, we found that the annulus of the previous stentless valve gripped the CoreValve device. Any attempt to position the device by pulling back encountered considerable resistance. During this process of repositioning, the partially deployed CoreValve, the valve abruptly popped back across the stentless valve. We resheathed the device and removed it.

We next attempted to deploy a 29 mm CoreValve prosthesis with the plan to deploy the valve at a greater depth because of the asymmetry of the coronary cusps due to the previously described left cusp. Again when trying to adjust the depth of the device by pulling back on the valve, we encountered considerable resistance, with subsequent popout of the valve again. As with the first attempt, the bioprosthetic annulus gripped the CoreValve precluding adjustment. We resheathed the valve and removed it.

Finally, a third Corevalve prosthesis (26 mm) was attempted and successful deployment was obtained through a different strategy. Instead of allowing the valve to advance across the annulus with subsequent withdrawal to an optimal position, we pushed the wire against the LV apex, and oriented the device using the left coronary cusp as the reference. Pushing on the wire resulted in its being oriented against the greater curvature of the aorta (Fig. 4). Following partial deployment, we noted that the device was relatively deep with respect to the non- and right coronary cusps, but was ideally oriented to the deformed left coronary cusp. As opposed to the first two attempts, this time we simply pushed on the wire and did not pull back on the valve with our usual counter-traction. This maneuver resulted in a more optimal angle across the aortic valve, which better matched the orientation of the stentless valve and allowed for successful deployment (Figs. 5 and 6). Postprocedure TEE showed negligible aortic regurgitation. The postprocedure transvalvular gradient was 8 mmHg. The patient had a rapid postprocedure recovery and reported much improved symptoms by the time of discharge. Discharge TTE showed mild-moderate perivalvular aortic regurgitation (Fig. 7) and follow-up transthoracic echocardiogram at five months showed a well-seated valve with mild perivalvular aortic regurgitation and complete resolution of his LV function to normal.

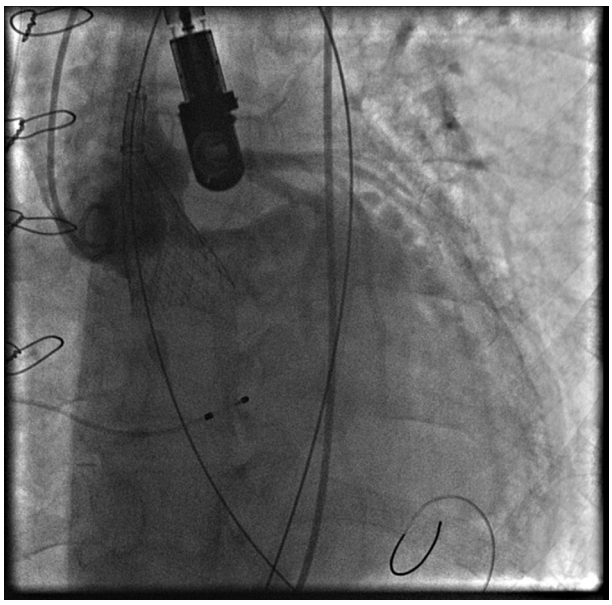

Figure 3. Angiographic image of wire/valve angle during first unsuccessful attempt at deployment. Partial deployment of the CoreValve is demonstrated, with a relatively vertical angle that leans the CoreValve against the lesser curvature of the aortic arch.

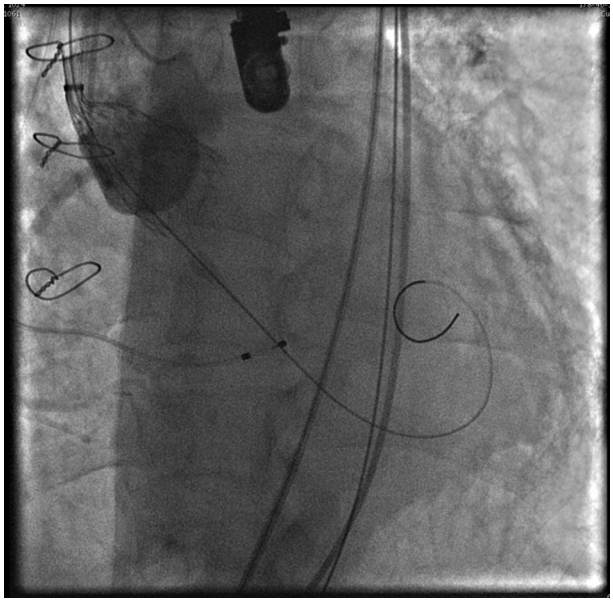

Figure 4. Angiographic image of wire/valve angle during subsequent successful deployment. Partial deployment of the CoreValve is demonstrated, with a more horizontal angle than the previous attempt, resulting in the CoreValve leaning more toward the greater curvature of the aortic arch.

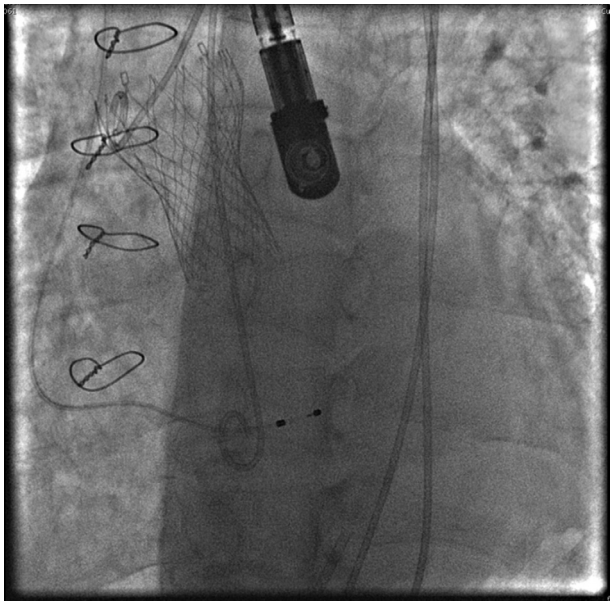

Figure 5. Fully deployed 26 mm CoreValve within the St. Jude Toronto stentless porcine aortic valve.

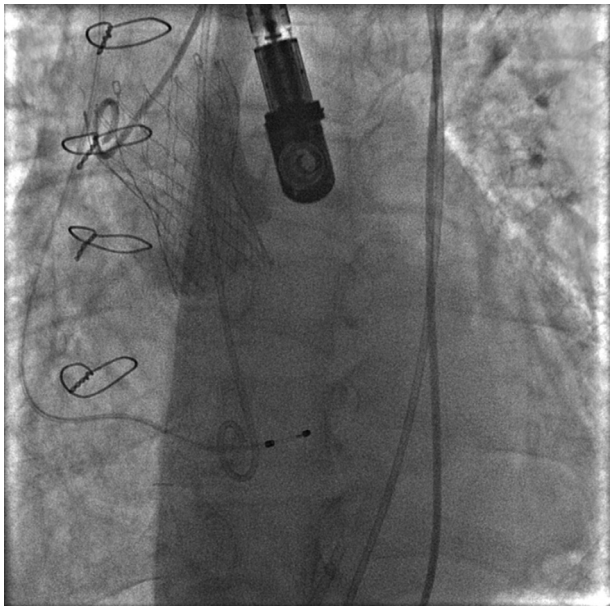

Figure 6. Aortic root angiogram demonstrating final position of CoreValve within St. Jude Toronto stentless porcine aortic valve, with minimal aortic regurgitation.

Discussion

Our first experience with a stentless porcine valve-in-valve TAVR demonstrated many key issues that are crucial to procedural success: (1) the importance of sizing for a stentless valve-in-valve procedure, (2) a different wire technique required in order to successfully deploy a valve-in-valve in the setting of a difficult angle and unusual valve anatomy, and (3) awareness of the difficulty in pulling back the CoreValve prosthesis into position through a previous stentless valve.

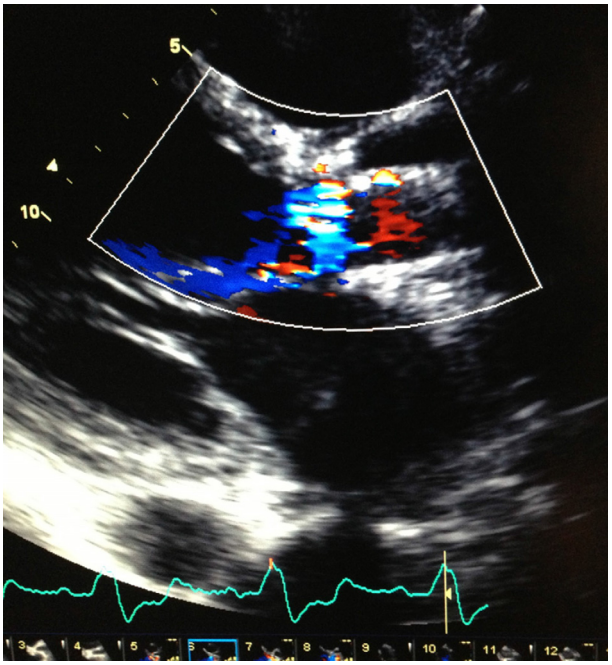

Figure 7. Transthoracic echocardiogram demonstrating mild-moderate perivalvular leak s/*P* valve-in-valve deployment.

Valve-in-valve sizing

Based on the guidelines for sizing from Medtronic, an aortic annulus diameter of 20–23 mm should require a 26 mm CoreValve prosthesis, an aortic annulus diameter of 23–27 mm should require a 29 mm CoreValve and a 26-29 mm aortic annulus diameter should require a 31 mm CoreValve. Based on our patient's aortic annulus perimeter of 76.6 mm, which corresponds to an average diameter of 24.4 mm, the appropriate size CoreValve prosthesis should be a 26 mm valve.

However, the actual valve dimensions are more elliptical than circular, measuring 20.4 × 29.2 mm. Therefore, we considered that with one dimension as long as 29.2 mm, it might be preferable to use a 29 mm CoreValve. While we were ultimately successful in deploying a 26 mm valve, we believe that our success in the end was likely due to a change in wire technique rather than a difference in valve sizing. Further experience will be helpful in making optimal sizing decisions. Of note, our follow-up echo showed mild aortic insufficiency; it is possible this may have been decreased with the use of a 29 mm valve.

Wire technique with difficult angles

While we have previously deployed numerous valves with very horizontal angles (not uncommonly 50° or more), and although this valve only had an angle of 35.5 per the CT scan, the angle along with the partially amputated left coronary cusp posed a more substantial problem than in any of our prior procedures. Our usual technique for positioning the CoreValve is to push the stiff wire against the LV apex, while pulling back with counter-traction on the CoreValve to provide optimal final positioning after partial deployment. When we tried this method with both the 26 mm and 29 mm CoreValve prostheses initially, it did not work.

When we finally took the approach of pushing the stiff wire against the LV apex without pulling back on the CoreValve, this maneuver allowed the CoreValve to lean closer to the greater curvature of the aortic arch, thus sitting more horizontally inside the stentless valve for optimal alignment.

Pullback through a stentless valve

A final key lesson for us was that the usual smooth pullback of the CoreValve once partially deployed does not work as well when pulling back through a stentless valve. Once partially deployed, the annulus of the prosthetic valve grips the CoreValve device, making repositioning very difficult. On our first attempt, when we pulled back the CoreValve gently across the stentless valve, it unexpectedly popped back across the valve. When we attempted again with a larger prosthesis, after partial deployment, it caught on the stentless valve, making it difficult to pullback. Ultimately, enough pulling caused it to pop back across the valve rather than sliding back gradually for completion of deployment. During our last attempt, before partial deployment, we carefully positioned the CoreValve with our new wire technique for optimal axis orientation, being careful to not start too low to avoid needing to pull back across the stentless valve. This maneuver successfully allowed for full deployment at the appropriate angle and height without requiring any pullback.

Successful completion of this procedure supports the idea that stentless valve-in-valve TAVR can be a feasible alternative to redo aortic valve surgery in a high- risk patient, if the technical aspects of the procedure can be overcome. In this setting, we recommend careful attention to CoreValve size choice, revised aggressive wire technique for angle optimization, and careful initial positioning to avoid the need for repositioning once partially deployed.

Acknowledgments

We thank Dr. James Fann and Dr. Thomas Burden, as well as the entire team of physicians and staff at the VA Palo Alto HCS who participated in the care of this patient.

Conflict of Interest

None declared.

References

1. Wenaweser, P., L. Buellesfeld, U. Gerckens, and E. Grube. 2007. Percutaneous aortic valve replacement for severe aortic regurgitation in degenerated bioprosthesis: the first valve in valve procedure using the Corevalve Revalving system. Catheter. Cardiovasc. Interv. 70:760–764.
2. Bapat, V., R. Attia, S. Redwood, et al. 2012. Use of transcatheter heart valves for valve-in-valve implantation in patients with degenerated aortic bioprosthesis: technical considerations and results. J. Thorac. Cardiovasc. Surg. 144:1372–1379.
3. Dvir, D., J. Webb, S. Brecker, et al. 2012. Transcatheter aortic valve replacement for degenerative bioprosthetic surgical valves: results from the global valve-in-valve registry. Circulation 126:2335–2344.
4. Linke, A., Woite F, Merx MW, Schiefer C, Möbius-Winkler S, Holzhey D, et al. 2012. Valve-in-valve implantation of Medtronic CoreValve prosthesis in patients with failing bioprosthetic aortic valves. Circ. Cardiovasc. Interv. 5: 689–697.
5. Gotzmann, M., A. Mügge, and W. Bojara. 2010. Transcatheter aortic valve implantation for treatment of patients with degenerated aortic bioprostheses–valve-in-valve technique. Catheter. Cardiovasc. Interv. 76:1000–1006.
6. Dvir, D., A. Assali, H. Vaknin-Assa, et al. 2011. Transcatheter aortic and mitral valve implantations for failed bioprosthetic heart valves. J. Invasive Cardiol. 23: 377–381.

