

Transcatheter Aortic Valve Implantation Despite Challenging Vascular Access

Angelo Nascimbene, MD
Federico Azpurua, MD
James J. Livesay, MD
R. David Fish, MD
Zvonimir Krajcer, MD

We describe transcatheter aortic valve implantation in a patient who had severe peripheral artery disease. The patient's vascular condition required additional preliminary peripheral intervention to enable adequate vascular access.

A 78-year-old man with severe aortic stenosis, substantial comorbidities, and severe heart failure symptoms was referred for aortic valve replacement. The patient's 20-mm aortic annulus necessitated the use of a 23-mm Edwards SAPIEN valve inserted through a 22F sheath, which itself needed a vessel diameter of at least 7 mm for percutaneous delivery. The left common femoral artery was selected for valve delivery. The left iliac artery and infrarenal aorta underwent extensive intervention to achieve an intraluminal diameter larger than 7 mm. After aortic valvuloplasty, valve deployment was successful, and the transaortic gradient decreased from 40 mmHg to less than 5 mmHg. The patient was discharged from the hospital 4 days postoperatively. We conclude that transcatheter aortic valve implantation can be successfully performed in patients with obstructed vascular access, including stenosis of the infrarenal aorta and the subclavian and coronary arteries. (*Tex Heart Inst J* 2015;42(2):144-7)

Presented at the Adriatic Vascular Summit, Siena, Italy, 5–8 September 2012.

Key words: Aortic valve stenosis/therapy; catheterization, peripheral/adverse effects; endovascular procedures; heart valve prosthesis implantation/instrumentation/methods; patient selection; peripheral arterial disease/complications/therapy; risk factors; stents; treatment outcome; ultrasonography, interventional

From: Departments of Cardiology (Drs. Azpurua, Fish, Krajcer, and Nascimbene) and Cardiothoracic Surgery (Dr. Livesay), Texas Heart Institute, Houston, Texas 77030

Address for reprints: Zvonimir Krajcer, MD, Department of Cardiology, Texas Heart Institute, Suite 2780, 6624 Fannin St., Houston, TX 77030

E-mail: Zvonkomd@aol.com

© 2015 by the Texas Heart[®] Institute, Houston

Trascatheter aortic valve implantation (TAVI) has emerged as a mainstream therapeutic option for valve replacement in patients who are at extreme surgical risk.¹ Cardiologists and cardiac surgeons now consider TAVI in patients who have been deemed poor candidates for aortic valve replacement because of their substantial comorbidities.²⁻⁴ Careful preoperative planning is crucial in selecting the proper strategy, avoiding intraoperative pitfalls in patients with marginal overall reserve, and minimizing surgical intervention for aortic valve stenosis.⁵ The TAVI procedure requires expertise in peripheral and coronary interventional techniques, including large-bore intravenous access.⁶ Until recently, lower-profile delivery systems for TAVI were not available in the United States.

We describe a case of TAVI that was complicated by severe peripheral artery disease. The elderly patient had contraindications to vascular access that initially made him ineligible for TAVI, so we also describe the additional interventions that were necessary to enable TAVI.

Case Report

In May 2012, a 78-year-old man with critical limb ischemia, recurrent angina, prior aortocoronary bypass, severe aortic stenosis, and New York Heart Association functional class IV symptoms of heart failure was referred for possible aortic valve replacement. His estimated Society of Thoracic Surgeons risk score for TAVI was 21%.² His aortic valve area was 0.6 cm²/cm², which resulted in secondary pulmonary hypertension, a systolic pulmonary artery pressure of approximately 70 mmHg, a moderately depressed left ventricular ejection fraction (0.45), and chronic atrial fibrillation. The patient had substantial additional comorbidities, including end-stage renal disease and tissues weakened by previous mediastinal radiation therapy for a lymphoma.

Transesophageal echocardiograms revealed a 20-mm annular diameter. This annular size necessitated the use of a 23-mm Edwards SAPIEN[®] valve (Edwards Lifesciences LLC; Irvine, Calif), delivered through a 22F RetroFlex[®] delivery system (Edwards Lifesciences) in accordance with the manufacturer's recommendation. A 7-mm vessel

diameter was necessary for percutaneous valve delivery. In addition to transesophageal echocardiography (in accordance with our institution's protocol for TAVI), we performed computed tomographic (CT) angiography, right and left cardiac catheterization, and aortoiliac angiography.

The CT angiogram showed extensive and diffuse disease in multiple areas. In particular, the infrarenal aorta was severely calcific, with multiple stenoses that reduced the aortic diameter to less than 2.7 mm (Fig. 1).

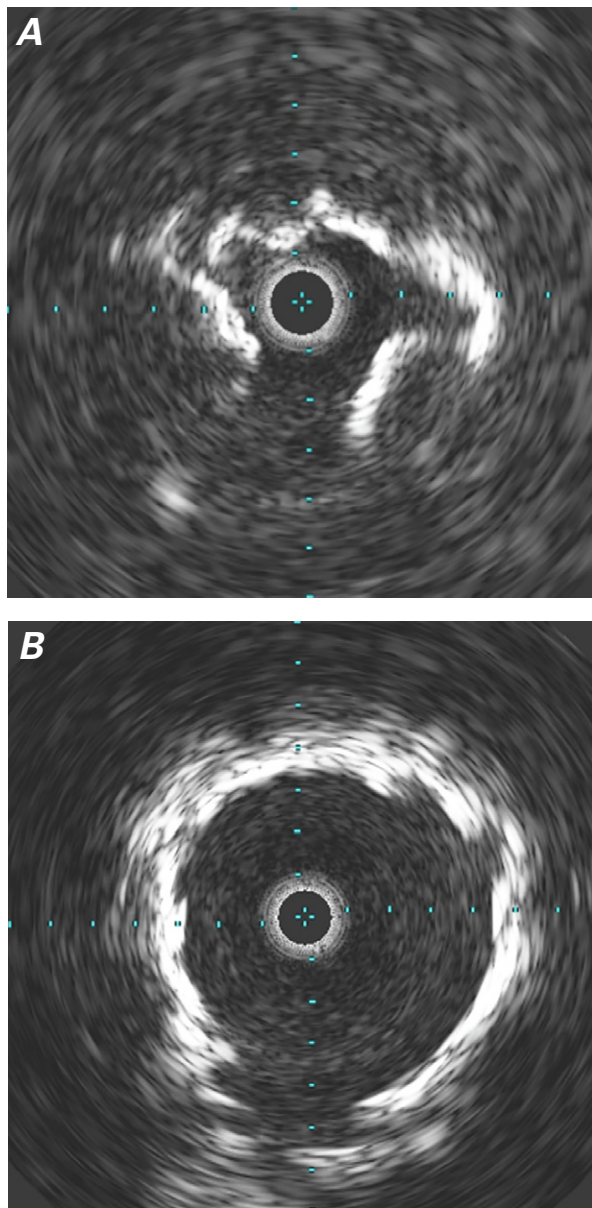


Fig. 1 Intravascular ultrasonograms show the portion of the infrarenal abdominal aorta with the smallest luminal diameter. **A)** Before intervention, the narrowest aortic segment was 2.7 mm in maximal transverse diameter. **B)** After the deployment of 2 overlapping iCAST™ stents, the maximal luminal diameter was 7.1 mm, enough to accommodate the RetroFlex® delivery system transfemorally.

We decided to perform TAVI through the left common femoral artery, because it had a diameter of 8 mm and only mild disease in its distal portion.

Because of the severely calcific stenosis of the infrarenal abdominal aorta, we performed a staged procedure 2 months before TAVI. Two overlapping iCAST™ stent-grafts—a 9 × 59-mm proximal stent and a 10 × 38-mm distal stent (Atrium Medical Corporation; Hudson, NH)—were deployed in the abdominal aorta distal to the takeoff of the superior mesenteric artery. Intravascular ultrasonography was used to guide real-time stent sizing and to evaluate the endoluminal results after stenting (Fig. 2). A CT reconstruction image of the abdominal aorta after the staged intervention showed that the distal aorta had acquired sufficient caliber to accommodate the 22F delivery system. However, the image also showed some remaining critical stenoses at the aortoiliac junction that would have to be dealt with periprocedurally (Fig. 3).

On the day of TAVI, we gained access to the left radial artery with use of a 5F Glidesheath® (Terumo Medical Corporation; Somerset, NJ). This second access enabled us to advance a pigtail catheter from the radial artery to the aortic root for imaging throughout the procedure, whereas a 22F RetroFlex delivery system would have been occlusive and precluded the use of a second femoral access. As expected from the pre-TAVI computed tomogram, we had to perform several percutaneous transluminal angioplasty procedures to expand the left aortoiliac junction to a diameter of 7 mm. We deployed a 10 × 40-mm Atlas® PTA Dilatation Cath-

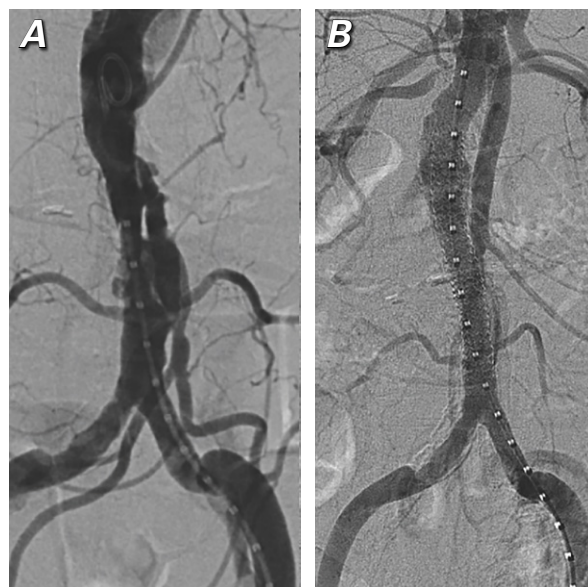


Fig. 2 Abdominal aortic angiograms obtained **A)** before and **B)** after 2 overlapping iCAST stent-grafts were deployed in the abdominal aorta distal to the renal artery ostia. Intravascular ultrasonography was used to confirm satisfactory real-time endoluminal results after stenting, as shown in Figure 1.

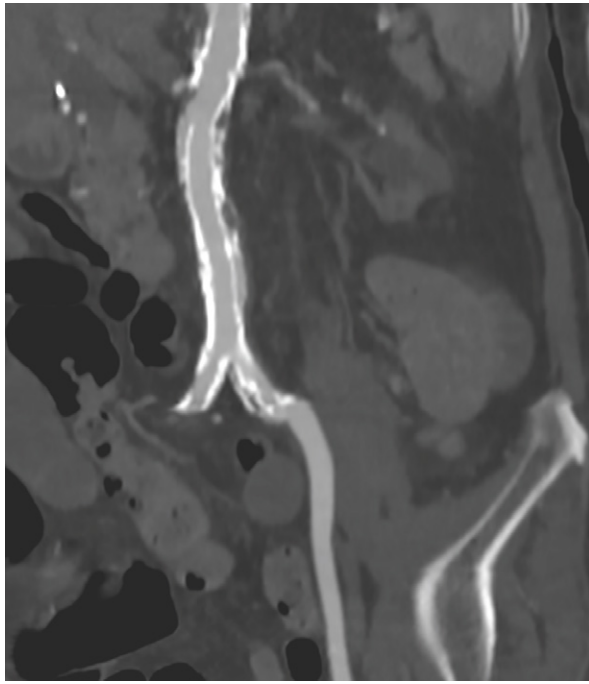


Fig. 3 Computed tomographic angiographic reconstruction image shows the abdominal aorta after intervention (right anterior projection), highlighting the access route from the left femoral artery to the iliac artery. The stent-grafted distal aorta had a caliber sufficient to accommodate a 22F delivery system. Critical stenoses remained at the left aortoiliac junction (estimated luminal diameters, 3.4–4.9 mm). Multiple percutaneous transluminal angioplasty procedures were performed in this region to enable RetroFlex delivery.

eter (Bard Peripheral Vascular Systems, Inc.; Tempe, Ariz) over a 0.035-in Amplatz Super Stiff™ Guidewire (Boston Scientific Corporation; Natick, Mass). After the 7-mm vessel was secured, access was obtained by means of a cutdown of the left common femoral artery, and a 22F RetroFlex delivery system was advanced into the abdominal aorta. The stenotic aortic valve was crossed with a 5F multipurpose catheter (Cordis, a Johnson & Johnson company; Miami Lakes, Fla) over a 0.035-in straight wire. When the catheter was in the left ventricle, it was exchanged for a 0.035-in Lunderquist™ wire (Cook Medical, Inc.; Bloomington, Ind). We performed the aortic valvuloplasty with use of rapid right ventricular pacing and a 20 × 40-mm balloon (Edwards Lifesciences), which yielded minimal aortic regurgitation. Finally, we advanced the 22F RetroFlex delivery system—with the SAPIEN valve crimped over the delivery balloon—into the aortic annulus. Deployment was successful (Fig. 4). The transaortic gradient decreased from 40 mmHg to less than 5 mmHg. The left femoral artery was surgically repaired. The entire procedure took 3 hours 33 minutes. The patient was given 150 mL of angiographic contrast medium, and his total fluoroscopic exposure was 18 minutes. He was transferred to the postoperative intensive care unit, had an uneventful



Fig. 4 Cineangiographic image shows the 26-mm Edwards SAPIEN valve deployed in the aortic valve position.

stay, and was discharged from the hospital 4 days postoperatively. He was then lost to direct follow-up but was known to be alive several months afterwards.

Discussion

This report illustrates the use of TAVI in a patient who was not eligible for aortic valve replacement and who lacked suitable arterial access. Such patients traditionally have been excluded from surgical intervention because of the predicted high mortality rate.⁴ Cardiologists and cardiac surgeons have to overcome several challenges to perform TAVI in these “extreme-risk” patients, and vascular access is frequently the primary problem. In the PARTNER Trial,⁴ the prevalence of vascular sequelae was 20% because of the large profile of the delivery system that was used.

To date, 5 different vascular access methods for TAVI have been described: transfemoral, transapical, subclavian, direct aortic, and left carotid. At the time of this patient’s procedure, transapical access was not available in the United States, and the evidence supporting transcarotid delivery is anecdotal and controversial.⁷ We considered using the transaortic approach⁸ via a limited mini-sternotomy; however, this route was less appealing because of the patient’s 3 venous grafts (only 2 of which were still patent), a patent left internal mammary artery (LIMA)-to-left anterior descending coronary artery graft proximal to the sternum, and tissues weakened by the patient’s previous radiation therapy.

Subclavian and axillary artery access has become increasingly popular.^{9–11} In our patient, vessel dimension

and tortuosity made this option suboptimal. In addition to having small-caliber vessels, our patient was undergoing hemodialysis through a left brachial fistula, and even a limited dissection might have simultaneously jeopardized the LIMA and the fistula.

With only the transfemoral route available, we opted for the left axis because of its larger iliac vessel (as determined by means of CT angiography). We proceeded through the calcific and stenotic infrarenal aortic and iliac vessels by extensively covering them with 2 overlapping iCAST covered stents. In case of rupture, these stents would prevent the dreadful situation of retroperitoneal bleeding after stent deployment.

We also performed focal iliac percutaneous transluminal angioplasty with use of noncompliant balloons (8 × 40 and 10 × 40 mm). This route offered the largest possible access through a highly diseased vessel and, accordingly, the greatest chance of success. Our use of intravascular ultrasonography assisted in the real-time evaluation of vessel dimensions to guide intervention in specific vascular areas.

Arterial access can be a substantial challenge in patients in whom there are few options for treatment. Using current 22F–24F delivery systems to perform TAVI necessitates meticulous preoperative evaluation and planning, and possibly also staged interventions by cardiologists and surgeons.¹ Lower-profile devices will soon be available to meet the challenges presented by the newly treatable population of formerly “no-option” patients.⁷

Acknowledgments

We thank St. Luke’s Episcopal Hospital for providing logistic support and for its ongoing support of and commitment to graduate educational programs. Stephen N. Palmer, PhD, ELS, and Katherine Jenson, BA, contributed to the editing of the manuscript. James Philpot, ACE, prepared the figures.

References

1. Kodali SK, O’Neill WW, Moses JW, Williams M, Smith CR, Tuzcu M, et al. Early and late (one year) outcomes following transcatheter aortic valve implantation in patients with severe aortic stenosis (from the United States REVIVAL trial). *Am J Cardiol* 2011;107(7):1058-64.
2. Ben-Dor I, Gaglia MA Jr, Barbash IM, Maluenda G, Hauville C, Gonzalez MA, et al. Comparison between Society of Thoracic Surgeons score and logistic EuroSCORE for predicting mortality in patients referred for transcatheter aortic valve implantation. *Cardiovasc Revasc Med* 2011;12(6):345-9.
3. Ben-Dor I, Pichard AD, Satler LF, Goldstein SA, Syed AI, Gaglia MA Jr, et al. Complications and outcome of balloon aortic valvuloplasty in high-risk or inoperable patients. *JACC Cardiovasc Interv* 2010;3(11):1150-6.
4. Leon MB, Smith CR, Mack M, Miller DC, Moses JW, Svensson LG, et al. Transcatheter aortic-valve implantation for aortic stenosis in patients who cannot undergo surgery. *N Engl J Med* 2010;363(17):1597-607.
5. Jabbour A, Ismail TF, Moat N, Gulati A, Roussin I, Alpendurada F, et al. Multimodality imaging in transcatheter aortic valve implantation and post-procedural aortic regurgitation: comparison among cardiovascular magnetic resonance, cardiac computed tomography, and echocardiography. *J Am Coll Cardiol* 2011;58(21):2165-73.
6. Van Mieghem NM, Tchetché D, Chieffo A, Dumonteil N, Messika-Zeitoun D, van der Boon RM, et al. Incidence, predictors, and implications of access site complications with transfemoral transcatheter aortic valve implantation. *Am J Cardiol* 2012;110(9):1361-7.
7. Magalhaes MA, Souza JM, Grube E. Transcatheter aortic valve implantation through a diseased left common carotid artery: combined approach with endarterectomy and left carotid-subclavian bypass. *Catheter Cardiovasc Interv* 2013;81(4):618-22.
8. Webb JG, Wood DA. Current status of transcatheter aortic valve replacement. *J Am Coll Cardiol* 2012;60(6):483-92.
9. Taramasso M, Maisano F, Cioni M, Denti P, Godino C, Montorfano M, et al. Trans-apical and trans-axillary percutaneous aortic valve implantation as alternatives to the femoral route: short- and middle-term results. *Eur J Cardiothorac Surg* 2011;40(1):49-55.
10. Petronio AS, De Carlo M, Bedogni F, Maisano F, Ertori F, Klugmann S, et al. 2-year results of CoreValve implantation through the subclavian access: a propensity-matched comparison with the femoral access. *J Am Coll Cardiol* 2012;60(6):502-7.
11. Schafer U, Ho Y, Frerker C, Schewel D, Sanchez-Quintana D, Schofer J, et al. Direct percutaneous access technique for transaxillary transcatheter aortic valve implantation: “the Hamburg Sankt Georg approach”. *JACC Cardiovasc Interv* 2012;5(5):477-86.