Combined Retrograde/ Antegrade Approach to Transcatheter Closure of an Aortic Paravalvular Leak

Abdulla A. Damluji, MD, MPH
Husnu E. Kaynak, MD
Alan W. Heldman, MD, FSCAI

New interventional techniques have made transcatheter closure of aortic paravalvular leaks a viable therapeutic option to treat the sequelae of these defects, including congestive heart failure and hemolysis. We report the transcatheter closure of an aortic paravalvular leak via a combined retrograde/antegrade approach. This was necessary because of difficulty in crossing the defect with a sheath from the retrograde approach. This technique might be useful in application to other difficult structural heart interventions. To our knowledge, this is the first report of a treated paravalvular leak around a Mitroflow® Aortic Pericardial Heart Valve. ***(Tex Heart Inst J 2015;42(5):443-7)***

Key words: *Aortic regurgitation; aortic valve; congestive heart failure; echocardiography, transesophageal; heart valve prosthesis; percutaneous closure; treatment outcome*

From: *Cardiovascular Division and the Elaine and Sydney Sussman Cardiac Catheterization Laboratory, University of Miami Hospital, Miller School of Medicine, Miami, Florida 33136*

Dr. Kaynak is now at the Yuma Cardiac Center, University of Arizona, Phoenix School of Medicine.

Address for reprints: *Alan W. Heldman, MD, FSCAI, 8150 SW 53rd Ave., Miami, FL 33143*

E-mail: *aheldman@gmail.com*

Paravalvular leaks (PVLs) are well-recognized sequelae of surgically implanted prosthetic aortic valves. The reasons for PVL include tissue friability, annular calcification, and infection.[1] Although some PVL patients remain asymptomatic for many years, others develop congestive heart failure or hemolysis and need reoperation. Transcatheter closure by implanting an occluder device has become an alternative to surgery for leak closure; treatment of an aortic PVL can often, in fact, be performed via a femoral artery retrograde approach, with the aid of echocardiographic and fluoroscopic guidance.[1] An antegrade approach can be substituted if retrograde treatment cannot be performed; access for antegrade treatment can be via the femoral vein and transseptal puncture, or via a left ventricular (LV) transapical approach.[1] We report the closure of an aortic PVL via a combined retrograde/antegrade approach, which became necessary because neither the simple retrograde nor the antegrade approach could be completed.

Case Report

In September 2012, an 85-year-old woman presented with New York Heart Association functional class III/IV heart failure, persistent atrial fibrillation, and severe aortic stenosis. She underwent aortic valve replacement (AVR) with a 21-mm bovine Mitroflow® Aortic Pericardial Heart Valve (Sorin Group Canada Inc., Mitroflow Division; Burnaby, Canada). Over the next year, she developed severe paravalvular regurgitation and heart failure. The risk of reoperation was high (the Society of Thoracic Surgeons risk calculator estimated the risk of operative death at 9.6%). Transcatheter closure of the aortic PVL was advised. Transesophageal echocardiography (TEE) revealed severe aortic regurgitation from a crescent-shaped PVL, 5 to 6 mm in its largest dimension, located below and posterior to the ostium of the right coronary artery, and surrounded by mild aortic root calcification (Figs. 1 and 2).

Implantation of a closure device into the paravalvular defect was performed with the patient under general anesthesia. Imaging guidance was with real-time TEE and with the use of a 3-dimensional computed tomographic reconstruction of the patient's aortic root generated from a rotational root aortogram created with use of *syngo*® DynaCT 360 software (Siemens Healthcare GmbH; Erlangen, Germany). Briefly, we paced the right ventricle at a rate of 180 beats/min to achieve hypotension, whereupon we performed rotational aortography by injecting, at a rate of 15 cc/s, a total of 70 cc of contrast medium diluted to 40%. This approach enabled us to identify the location of the large leak, which corresponded to the TEE findings. We annotated the site of interest with use of *syngo*® iGuide Toolbox software (Siemens Healthcare) and

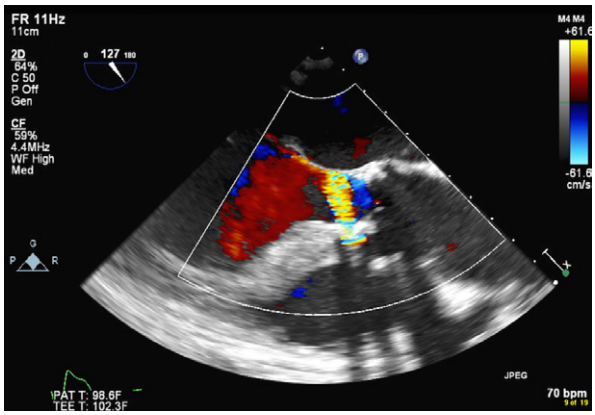

Fig. 1 *Two-dimensional transesophageal echocardiogram shows severe aortic regurgitation caused by a crescent-shaped paravalvular leak.*

Supplemental motion image is available for Figure 1.

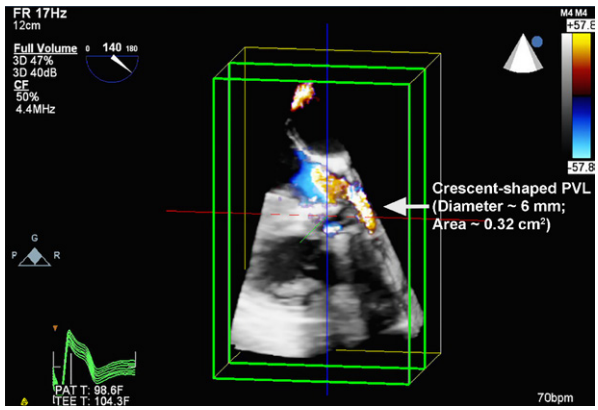

Fig. 2 *Three-dimensional transesophageal echocardiogram shows severe aortic regurgitation caused by a crescent-shaped paravalvular leak (PVL).*

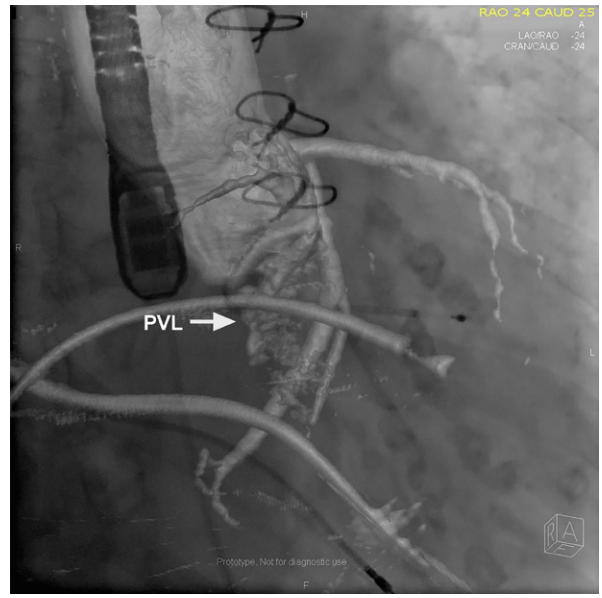

Fig. 3 *Three-dimensional computed tomogram is projected in real-time integration with a biplane imaging system and overlay on the A-plane, which enabled the passage of a guidewire across the paravalvular leak (PVL).*

projected that annotation as real-time integration with a biplane imaging system and overlay on the A-plane; this enabled us to pass a guidewire across the defect (Fig. 3).[2]

From the femoral artery, with use of a 6F multipurpose angiographic catheter (Boston Scientific Corporation; Natick, Mass), we easily passed a straight-tipped, hydrophilic Radifocus® Glidewire® Advantage™ Peripheral Guidewire (Terumo Interventional Systems; Tokyo, Japan) retrograde from the aorta to the LV, through the PVL; however, the catheter would not cross the defect. A 4F GLIDECATH® hydrophilic Coated Catheter (Terumo) was able to cross over this wire, and through that catheter we shuttled an Amplatz Super Stiff™ Guidewire (Boston Scientific) across the defect into the LV. Despite this support, a 7F DESTINATION® guiding sheath with tapered dilator (Terumo) could not cross the defect either, so retrograde delivery of the planned occluder device by this means was not possible. While maintaining in place a retrograde Rosen® guidewire (Cook Medical, Inc.; Bloomington, Ind), we attempted conversion to a transseptal antegrade approach by advancing an 8F Mullins sheath across the interatrial septum and left atrium to the LV. Despite our maneuvers with a range of catheter shapes, we could not cross the PVL with a guidewire from the antegrade approach.

Next we tried a combined retrograde/antegrade approach (Fig. 4). We delivered, transseptally into the LV, an 18- to 30-mm snare (EN Snare® Endovascular Snare System, Merit Medical Systems, Inc.; S. Jordan, Utah) and thereby captured the tip of the retrograde guidewire, which we retracted into the snare's sheath. By means of antegrade traction on the retrograde femoral artery wire, we advanced the snare system antegrade across the paravalvular defect. Then we released the snare and withdrew it. Through the snare's sheath, a 400-cm-long Nitrex® nitinol guidewire (ev3 Endovascular, Inc., part of Covidien; Plymouth, Minn) was advanced antegrade and snared in the lower aorta; complete exteriorization of this kink-resistant wire was achieved. Care was taken to maintain a large loop in the left heart.[3] A 7F, 90-cm, coil-reinforced DESTINATION sheath crossed easily: femoral vein to right atrium to left atrium to LV, across the paravalvular defect and into the ascending aorta. A 13-mm AMPLATZER® septal occluder (St. Jude Medical, Inc.; St. Paul, Minn) was delivered through this system. Closure of the PVL was confirmed by means of TEE; however, this device impinged upon the orifice of the right coronary artery, so it was not deployed. The occluder was instead withdrawn; with this,

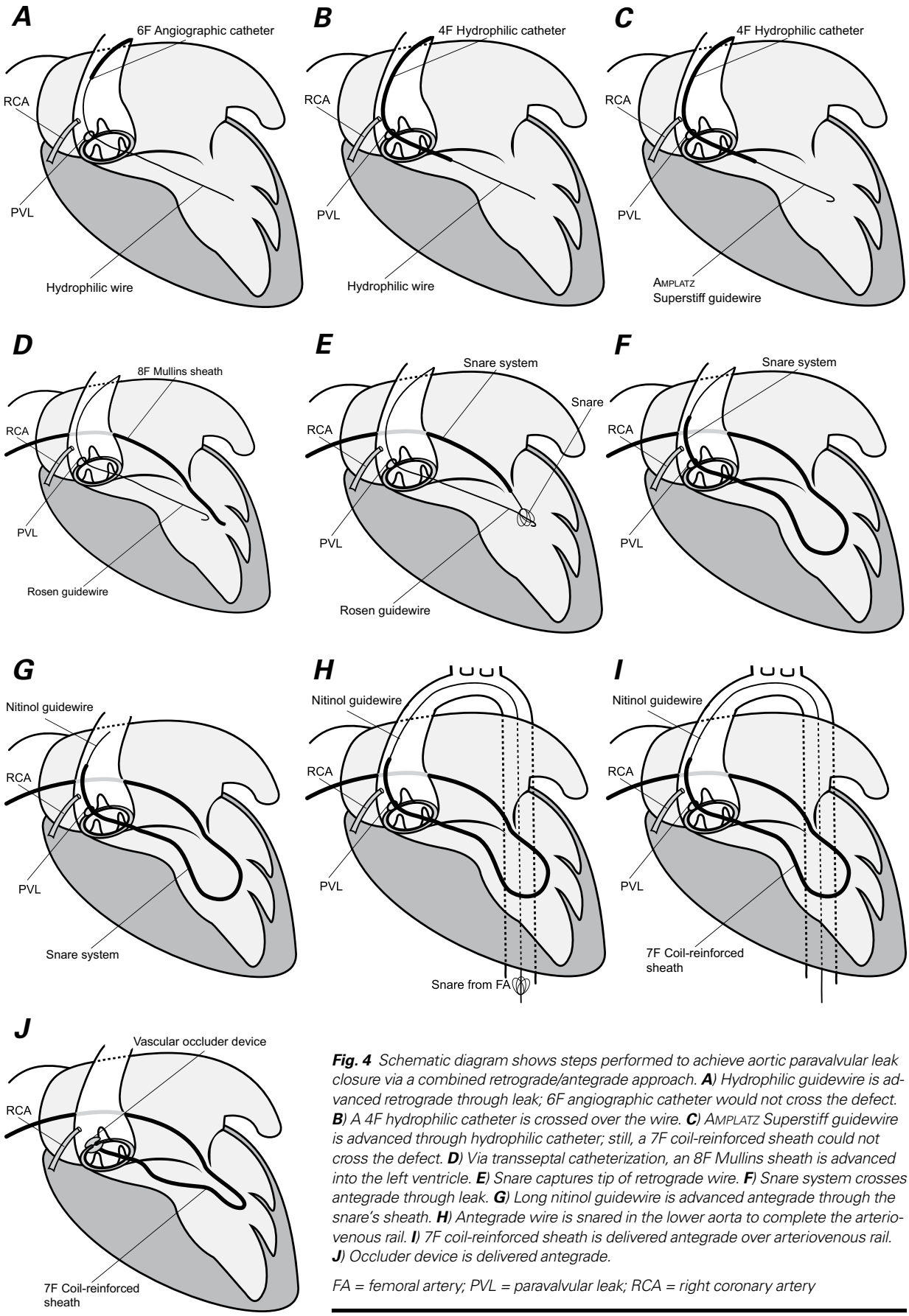

Fig. 4 *Schematic diagram shows steps performed to achieve aortic paravalvular leak closure via a combined retrograde/antegrade approach.* ***A****) Hydrophilic guidewire is advanced retrograde through leak; 6F angiographic catheter would not cross the defect.* ***B****) A 4F hydrophilic catheter is crossed over the wire.* ***C****) Amplatz Superstiff guidewire is advanced through hydrophilic catheter; still, a 7F coil-reinforced sheath could not cross the defect.* ***D****) Via transseptal catheterization, an 8F Mullins sheath is advanced into the left ventricle.* ***E****) Snare captures tip of retrograde wire.* ***F****) Snare system crosses antegrade through leak.* ***G****) Long nitinol guidewire is advanced antegrade through the snare's sheath.* ***H****) Antegrade wire is snared in the lower aorta to complete the arteriovenous rail.* ***I****) 7F coil-reinforced sheath is delivered antegrade over arteriovenous rail.* ***J****) Occluder device is delivered antegrade.*

FA = femoral artery; PVL = paravalvular leak; RCA = right coronary artery

the delivery sheath again crossed the defect antegrade. A 10-mm AMPLATZER vascular plug II (St. Jude Medical) was delivered, positioned, and, after confirmation of leak closure and secure positioning, was deployed (Fig. 5).

The patient's length of stay at the hospital was 2 days. She was treated with aspirin and clopidogrel. At her 2-month follow-up visit, transthoracic echocardiography revealed a trace of intravalvular aortic insufficiency, no PVL, and no evidence of wear and tear on the valve leaflets (Fig. 6). During that visit, the aspirin was discontinued and warfarin was restarted for prevention of ischemic stroke. Two years later, she remained active without limiting symptoms related to congestive heart failure. Transthoracic echocardiography revealed no evidence of erosions of the valve leaflets (Fig. 7).

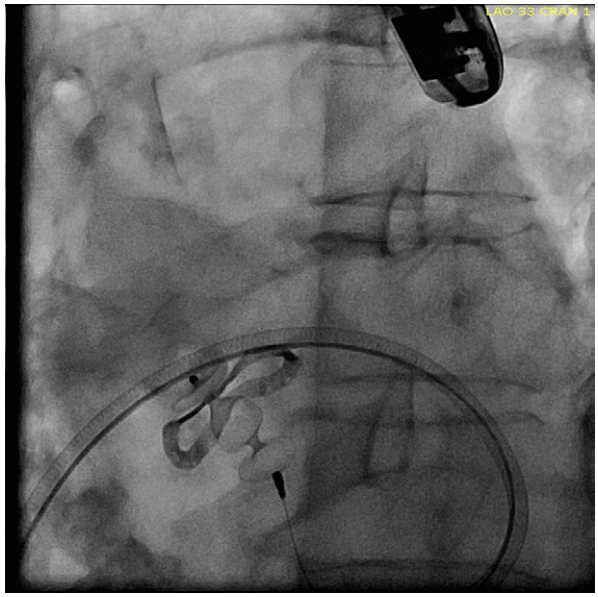

Fig. 5 *Coronary angiogram shows the deployment of a 10-mm AMPLATZER® vascular plug II, which closed the paravalvular leak.*

Discussion

Surgical reoperation for the treatment of aortic PVLs is associated with substantial morbidity; transcatheter techniques have emerged as a promising alternative. However, given the absence of purpose-built occluders and the corresponding profusion of technically heterogeneous interventional devices, there are too few data on the safety and efficacy of transcatheter procedures. Sharing informative cases with other operators who perform these interventions can aid in future management of such challenges.

Our technique was influenced by earlier experience. We use multiple imaging methods to guide many structural heart interventions, including transcatheter AVR. Annotation upon the 3-dimensional image generated by rotational aortography, for example, has provided reliable anatomic guidance during structural heart disease procedures. Although the use of kink-resistant nitinol guidewire in earlier transseptal antegrade AVR procedures was helpful, the main factor in protecting the mitral valve is the maintenance of the arteriovenous (AV) loop within the LV, because the loop can otherwise be temporarily or permanently damaged. Mitral valve function can be impaired when the valve is held open by the guidewire.[3]

Snaring a wire or catheter in the LV can also lead to its entanglement in the mitral apparatus, so great care must be taken if the snaring technique is used. Three-dimensional echocardiography and biplane fluorosco-

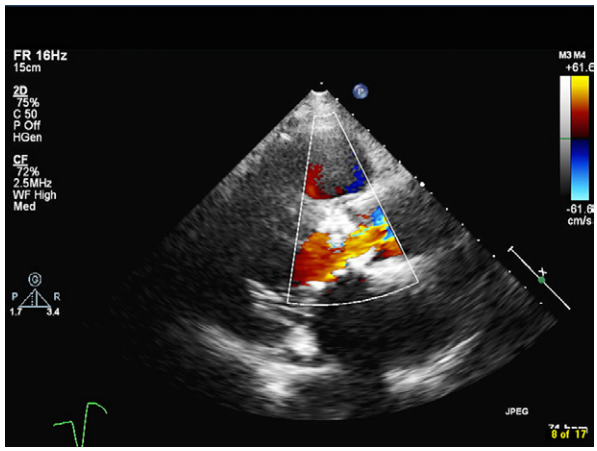

Fig. 6 *Transthoracic echocardiogram (parasternal long-axis view) shows a trace of intravalvular aortic insufficiency and no paravalvular leak.*

Supplemental motion image is available for Figure 6.

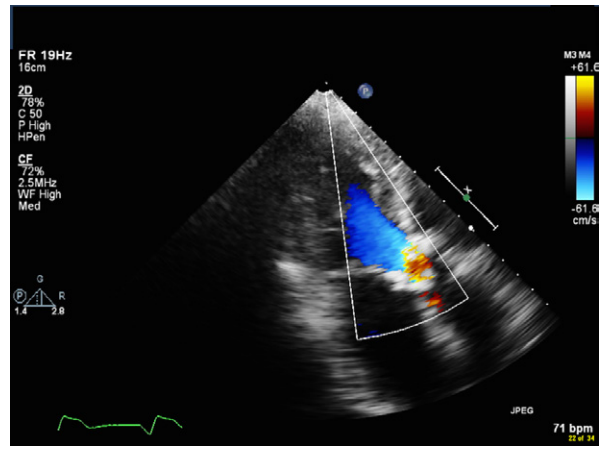

Fig. 7 *At the 2-year follow-up evaluation, transthoracic echocardiogram (apical 3-chamber view) shows no evidence of erosions on Mitroflow valve leaflets.*

Supplemental motion image is available for Figure 7.

py can reduce this risk. The left anterior oblique view might be optimal for delivery and positioning of the device, and the right anterior oblique view is ideal for displaying the maintenance of the large loop in the LV. If feasible, snaring within the aorta is perhaps a lower-risk approach. Although that additional step could have been avoided by initially exchanging the Amplatz Super Stiff wire for nitinol wire, we took it to avoid pulling the retrograde wire. The introduction of vascular plugs eliminates some of these challenges, because devices can now be delivered through even small angiographic catheters, making retrograde or transapical approaches more feasible in some cases.

It is important to note that the design of the Mitroflow differs from the designs of most other valves, in such a way that tissue interaction with the closure device will have future implications. The AMPLATZER septal occluder, comprising a braided nitinol wire mesh shaped into 2 flat discs with a connecting waist, is a self-centering, self-expandable device. Although the polyester fabric inserts are sewn into the nitinol wire mesh to promote tissue growth,[4] the thicker woven mesh could cause inflammatory reactions, erosion at the area of contact, and mechanical obstruction to the coronary ostium, which makes it less optimal when considering interaction with the Mitroflow valve.[5,6]

In contrast, the AMPLATZER vascular plug II is a 3-lobed device with 6 occlusive planes. The multilayered, multisegmented design of the vascular plug (and its finer woven mesh) might provide less interference with the Mitroflow valve.[7] However, this alternative will require close follow-up. The AMPLATZER duct occluder, without the presence of a proximal disc, might offer a better choice for transcatheter closure of Mitroflow prosthesis PVLs. The occluder would have to be deployed in a retrograde transaortic fashion, with its tapered waist placed securely within the PVL. Because the Mitroflow valve design places a single treated pericardial tissue sheet external to the valve struts, the risk of wear and tear on the valve leaflets (that is, erosion by the PVL device) remains.

Our patient's situation warranted treatment, and our decision to deliver an occluder device was the best that we could devise. The use of an AV rail as a support system was a necessary step in the course of this combined approach. (In fact, the improved support and control afforded by the AV rail might have enabled a repeat attempt to cross the PVL in a retrograde fashion.) Finally, we used a slightly oversized AMPLATZER vascular plug II to provide radial force and to avoid gaps where blood could flow around the device. However, caution should be exercised when using oversized devices for PVLs because of their tendency to elongate: proximal and distal discs tend to tilt toward the LV outflow tract and aorta, respectively, which raises the possibility of their obstructing the coronary arteries.[8] It should be noted that these AMPLATZER vascular plug II devices can be delivered through smaller sheaths (5F or 6F)—an important advantage over septal occluder devices.

Conclusion

Transcatheter closure of an aortic PVL can be performed with use of a combined retrograde/antegrade approach. The use of an AV rail is well known among practitioners of complex structural intervention; this case illustrates a novel approach to creating that AV rail, made necessary because of inability to cross retrograde with a catheter and to cross antegrade with a wire. This technique could be useful for other difficult structural heart interventions. To our knowledge, this is the first report of a treated paravalvular leak around a Mitroflow Aortic Pericardial Heart Valve.

References

1. Rihal CS, Sorajja P, Booker JD, Hagler DJ, Cabalka AK. Principles of percutaneous paravalvular leak closure. JACC Cardiovasc Interv 2012;5(2):121-30.
2. Binder RK, Leipsic J, Wood D, Moore T, Toggweiler S, Willson A, et al. Prediction of optimal deployment projection for transcatheter aortic valve replacement: angiographic 3-dimensional reconstruction of the aortic root versus multidetector computed tomography. Circ Cardiovasc Interv 2012;5(2):247-52.
3. Cohen MG, Singh V, Martinez CA, O'Neill BP, Alfonso CE, Martinezclark PO, et al. Transseptal antegrade transcatheter aortic valve replacement for patients with no other access approach - a contemporary experience. Catheter Cardiovasc Interv 2013;82(6):987-93.
4. Tobis J, Shenoda M. Percutaneous treatment of patent foramen ovale and atrial septal defects. J Am Coll Cardiol 2012;60(18):1722-32.
5. Amin Z, Hijazi ZM, Bass JL, Cheatham JP, Hellenbrand WE, Kleinman CS. Erosion of Amplatzer septal occluder device after closure of secundum atrial septal defects: review of registry of complications and recommendations to minimize future risk. Catheter Cardiovasc Interv 2004;63(4):496-502.
6. Sorajja P, Cabalka AK, Hagler DJ, Rihal CS. Percutaneous repair of paravalvular prosthetic regurgitation: acute and 30-day outcomes in 115 patients. Circ Cardiovasc Interv 2011;4(4):314-21.
7. Barwad P, Ramakrishnan S, Kothari SS, Saxena A, Gupta SK, Juneja R, et al. Amplatzer vascular plugs in congenital cardiovascular malformations. Ann Pediatr Cardiol 2013;6(2):132-40.
8. Delaney JW, Fletcher SE. Patent ductus arteriosus closure using the Amplatzer® vascular plug II for all anatomic variants. Catheter Cardiovasc Interv 2013;81(5):820-4.