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EDITORIAL COMMENT

Device Embolization in Transcatheter Aortic Valve Procedures

Expect the Unexpected*

Jose Carlos Moreno-Samos, MD, MSc,[a] Mladen I. Vidovich, MD[b]

Device embolization during transcatheter aortic valve replacement (TAVR) is a rare but potentially life-threatening complication. The reported device embolization (DE) incidence in TAVR in clinical trials was low—0.1% in PARTNER II (Placement of AoRTic TraNscathetER valves II) (Sapien XT, Edwards Lifesciences, Irvine, California), 0% in PARTNER 3 (Placement of AoRTic TraNscathetER valves 3) (Sapien 3, Edwards Lifesciences), and 0% in SURTAVI (SUrgical Replacement and Transcatheter Aortic Valve Implantation) (Corevalve/Evolut R) (Medtronic Inc., Minneapolis, Minnesota) (1-3). However, in the TRAVEL (TranscatheteR HeArt Valve EmboLization and Migration) registry, valve embolization was higher and occurred in 273 of 29,636 patients (0.92%) (4). Other real-life experiences from registry data varied from 0.3 to 1.1% (5,6). This difference in favor of clinical trials could be explained because registries usually include ventricular device migration and not complete embolization of the transcatheter valve from the annulus. Other possible reasons could be more experienced operators, strict procedure protocols, and less variability in TAVR valve type. A deep analysis of all patient-based DE cases would be required to bring more light to this matter.

Several mechanisms of DE can be identified: 1) anatomical factors (undersized prosthesis, bulky calcified leaflet, paucity of annular calcifications, interference with left ventricular [LV] structures like severe ventricular hypertrophy or mitral prosthesis struts, horizontal aortic annulus); 2) technical factors (high deployment, incomplete balloon inflation, pacing failure, premature pacing termination, post-dilatation of transcatheter valve, second valve implantation, failure to retract the delivery pusher, resuscitation maneuvers); and 3) device-related factors (due to manufacturing defects).

DE can occur despite optimal planning and procedure execution. An integrated algorithmic approach incorporating both percutaneous techniques and surgical modalities has been proposed and can be useful to manage this complication (7).

In this issue of *JACC: Case Reports*, Vendrik et al. (8) present an illustrative case of DE of a balloon-expandable prosthesis caused by loss of capture of the temporary pacemaker during deployment of the transcatheter valve under rapid cardiac pacing. Despite this major complication, Vendrik et al. (8) demonstrated skilled management to solve it percutaneously.

SEE PAGE 101

To become a skilled interventionalist, one needs to identify the cause of the complication and address it, but preventing it for future cases is even more important. For transcatheter valve replacement, a temporary transvenous pacemaker lead is inserted and placed in the right ventricle. Then, rapid cardiac pacing is performed to decrease cardiac output during valve delivery. This moment is especially important with a nonrecapturable balloon-expandable prosthesis because any pacing malfunction can lead to DE. The position of the pacemaker lead in the right ventricle has to be carefully checked and tested several times before the valve deployment process.

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From the [a]Interventional Cardiology Department, University Hospital of Jaen, Jaen, Spain; and the [b]University of Illinois, Chicago, Illinois. Dr. Vidovich has received a research grant from Boston Scientific; and has received royalties from Merit Medical. Dr. Moreno-Samos has reported that he has no relationships relevant to the contents of this paper to disclose.

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To minimize pacing malfunction, an alternative approach has been proposed—a modification of the ventricular guidewire to deliver unipolar pacing during valve delivery (9). The cathode of an external pacemaker is placed on the tip of the 0.035-inch guidewire, and the anode on a curved needle is inserted into the subcutaneous tissue near the groin. Insulation is provided by the TAVR catheter or balloon (in case a balloon aortic valvuloplasty is needed previously or if post-dilatation is required to achieve a better result). This minimalist approach using a LV guidewire for rapid pacing during TAVR could potentially prevent these types of complications and simplify the procedure.

Consequently, a dedicated temporary pacing guidewire has been developed; it allows both bipolar pacing and valve delivery. A first experience was recently published using this new guidewire and balloon-expandable prosthesis in TAVR and tricuspid valve-in-valve cases (10).

Once the device embolized to the aorta, Vendrik et al. managed it using a balloon to pull the device into the abdominal aorta, released it, and completed the procedure by delivering a second valve to the aortic annulus (8).

After the first learning point of this case—how to avoid pacing malfunction to prevent DE, we should focus on the second one—how to manage it if it does occur. When a balloon-expandable valve embolizes to the aorta, a percutaneous approach is preferred. A coaxial guidewire position must be maintained to avoid the inversion of the valve and a possible flow obstruction. Then, a valvuloplasty balloon can be inflated distal to the valve, and the valve can then be pulled to a secure position to avoid occlusion of side branches or aortic injury.

Implanting a covered stent into the dislocated prosthesis was proposed to exclude valvular action, as Vendrik et al. (8) mention, but this solution declined over time because a second functioning valve in aorta did not appear to have consequences during follow-up (7).

In case of LV DE, surgical removal is generally required. Some case reports described balloon-assisted recapture from the LV with subsequent redeployment. Despite this recapture-and-deploy success, in all of these cases, a second valve overlapping the first one was required (11,12).

Embolization of self-expandable valves is uncommon, due, at least in part, to valve design that enables recapture and repositioning. Nevertheless, use of self-expandable valves can lead to valve dislocation in some situations: during reposition of a low deployment valve using a snare technique (13); if post-dilatation is required after valve release (again pacing failure may result in valve migration); or in cases of intentional dislocation due to coronary artery occlusion or high deployment with severe aortic regurgitation. Self-expandable valves can be usually positioned in the ascending aorta using 1 or 2 snares, which avoids the occlusion of aortic arch branches.

Procedure-related complications are uncommon but inherent to any structural heart intervention; in addition to efforts in prevention and theoretical knowledge of different techniques and tools for optimal management, interventional cardiologists can receive valuable learning from case reports.

We congratulate Vendrik et al. (8) for the opportunity given to learn from their case, and how to prevent and deal with DE in TAVR. *JACC: Case Reports* provides, in this sense, a great platform for ongoing education based on challenging cases. When dealing with unexpected scenarios, necessity is the mother of invention and creative solutions appear in desperate situations. Therefore, knowing upfront all these cases, complications, and solutions, we can make a real difference should a complication occur, by saving time, and knowing our strategy, alternative approaches, and the tools required.

Complications happen, be ready for them.

ADDRESS FOR CORRESPONDENCE: Dr. Jose Carlos Moreno-Samos, Interventional Cardiology Department, University Hospital of Jaen, Avda Ejercito Español, 10, 23007 Jaen, Spain. E-mail: jcmorenosamos@gmail.com. Twitter: @JCMSamos.

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