A novel endovascular treatment for transcatheter aortic valve embolization

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ABSTRACT

In the present report, we have described the case of an 82-year-old obese man who had required transcatheter aortic valve replacement to treat severe symptomatic aortic stenosis. During implantation, the balloon-mounted valve became dislodged and embolized to the ascending aorta. A second valve was successfully implanted after several failed attempts to reposition the first one into the aortic annulus. The dislodged valve became further embolized and landed in the distal descending aorta, partially obstructing the splanchnic, renal, and lower extremity blood flow. It was rotated with flexible forceps and permanently secured in the distal thoracic aorta using a thoracic endoprosthesis, rendering it harmless. (J Vasc Surg Cases Innov Tech 2021;7:755-8.)

Keywords: Thoracic endovascular aortic repair; Transcatheter aortic valve implantation; Transcatheter aortic valve replacement; Transcatheter valve migration or embolization

Aortic stenosis (AS) is a leading cause of valvular heart disease.[1,2] Its prevalence increases with age, with an estimated incidence of 0.2% in the U.S. population aged ≥75 years.[2] Traditionally, surgical aortic valve replacement (SAVR) was the mainstay treatment of severe AS. Transcatheter aortic valve replacement (TAVR) has emerged as an alternative to SAVR for inoperable or high-risk surgical candidates and has significantly transformed the management of AS.[3] Unlike SAVR, in which the prosthetic valve is sutured to the aortic annulus, the valve in TAVR is either mounted on a high-pressure balloon and deployed by balloon inflation or delivered as a self-expanding device. Both approaches make it vulnerable to dislodgment, embolization, and migration.

Transcatheter valve embolization or migration (TVEM) has been extremely rare (~1% of all cases).[4] It can occur during the procedure, in the immediate period after implantation, or at any time thereafter and is associated with high morbidity and mortality.[4] The factors that lead to TVEM include valve undersizing, lack of calcification of the native aortic valve and annulus, inadequate identification of the landing zone, a loss of pacing capture during deployment or after dilatation, balloon slippage or rupture, and suboptimal valve expansion.[5] These post-TVEM sequelae highlight the need for increased awareness to the predisposing factors and the prompt availability of preventive and bailout measures to mitigate these risks.

A number of bailout techniques for treating TVEM have been described, including balloon-assisted repositioning, snare-assisted repositioning, valve-in-valve implantation, and conversion to open surgery.[6] In the present report, we have described a case of TVEM successfully managed using a novel endovascular bailout technique. The patient provided written informed consent for the report of his case details and imaging studies.

CASE REPORT

An 82-year-old obese man had presented because of symptomatic severe AS. A coronary arteriogram demonstrated two-vessel coronary artery disease that had been successfully managed with drug-eluting stents. He was offered TAVR owing to his increased surgical risk for SAVR. A 23-mm Edwards SAPIEN 3 (Edwards Lifesciences LLC, Irvine, Calif) aortic valve was selected, 20% oversized to a moderately calcified (calcium score, 1657 Agatston units) valve according to the findings from a preoperative computed tomography arteriogram. Premature ventricular beats recorded during implantation caused dislodgement and migration of the valve into the ascending aorta (Fig 1). A second 23-mm Edwards SAPIEN 3 valve (Edwards Lifesciences LLC) was successfully implanted in place after multiple failed repositioning attempts of the first valve, including snaring and balloon-assisted maneuvers.

The dislodged valve continued its antegrade migration to the aortic arch, partially occluding the blood flow distally. Repeated attempts to retrieve the prosthesis led to further migration downstream, until it eventually reached an upside-down position above the celiac artery within a 26-mm aorta and completely occluding distal blood flow. At this point, the

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Author conflict of interest: none.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

https://doi.org/10.1016/j.jvscit.2021.10.010

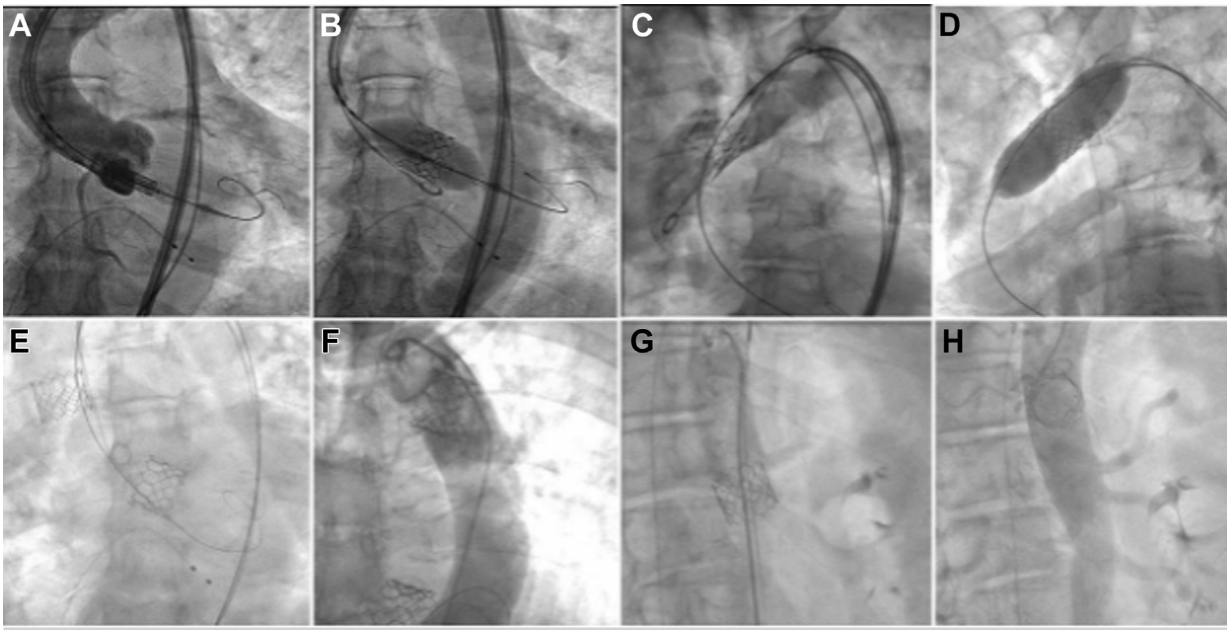

Fig 1. Transcatheter aortic valve replacement. **A,** Preimplantation angiogram. **B,** Implantation of the valve. **C,** Dislodging and migration of the valve to the ascending aorta. **D,** Balloon manipulation of the valve. **E,** New valve in place and original valve in the ascending aorta. **F,** The prosthesis in the descending aorta, allowing distal blood flow. **G,** Occlusion of the distal blood flow due to valve rotation. **H,** Horizontal valve position, allowing distal blood flow.

prosthesis was rotated horizontally to allow blood flow through the bare metal struts. An aortogram demonstrated reconstitution of the distal blood flow (Fig 1, *H*) with restoration of the palpable femoral pulses and without clinical or laboratory signs of splanchnic, renal, or peripheral ischemia. Full anticoagulation with intravenous heparin was continued, and the patient was transferred to the coronary care unit for further monitoring and assessment of the retrieval options.

The next day, the patient was taken to the operating room. Given the anatomic location, the valve diameter in relation to the descending aortic diameter, and the need to avoid open surgical reconstruction, we opted for an endovascular solution. Vascular access was achieved via the bilateral superficial femoral arteries (SFAs) and left axillary artery cut-downs. A 7F hockey stick Destination guiding sheath (Terumo Corp, Tokyo, Japan) was advanced through a 10F Pinnacle introducer sheath (Terumo Corp) from the right SFA into the abdominal aorta. An 8.5F Destino steerable guiding sheath (Oscor, Palm Harbor, Fla) was advanced through a 12F introducer sheath from the left axillary artery into the upper descending thoracic aorta. A 20F Dry-Seal sheath (W.L. Gore & Associates, Flagstaff, Ariz) was then placed in the left SFA. A 2.0-mm rat tooth grasping forceps (Olympus, Tokyo Japan) was inserted through the right SFA sheaths, and a 2.3 mm endoscopic grasping forceps (Micro-Tech, Nanjing China) was introduced through the left axillary artery sheaths.

The prosthesis was grasped using both forceps (Fig 2) and carefully rotated to a downward-facing position, allowing normal blood flow distally. It was then repositioned ~3 cm above the celiac artery to ensure a sufficient landing zone for an aortic endoprosthesis (Fig 2). Once the desired position of the valve had been achieved, a 31- × 100-mm thoracic endoprosthesis (conformable Gore TAG; W.L. Gore & Associates) was inserted through the left SFA sheath into the descending thoracic aorta and deployed within the valve to permanently secure it in place. A completion aortogram and postoperative computed tomography angiogram demonstrated satisfactory positioning of the aortic stent-graft inside the prosthetic aortic valve (Fig 3) generating a calculated 15% diameter stenosis, without flow restriction and no endoleaks (Fig 4). The patient experienced a full recovery and was discharged 2 weeks after hospital admission.

DISCUSSION

Proved as a safe and effective alternative, the use of TAVR has been increasing in popularity for severe AS,[7] albeit several serious complications have occurred, such as annular rupture, aortic dissection, coronary obstruction, and valve embolization and migration, with the latter having a higher incidence, although, curiously, it has been less commonly addressed.[8,9] The TRAVEL (transcatheter heart valve embolization and migration) registry identified five predisposing factors for TVEM, including malpositioning (50.2%), manipulation (20%), postdilatation (5.9%), sizing error (5.1%), and fast-rate pacing failure (4.8%).[4]

Cribier et al[10] recognized the grave consequences of valve migration when they first described the technique

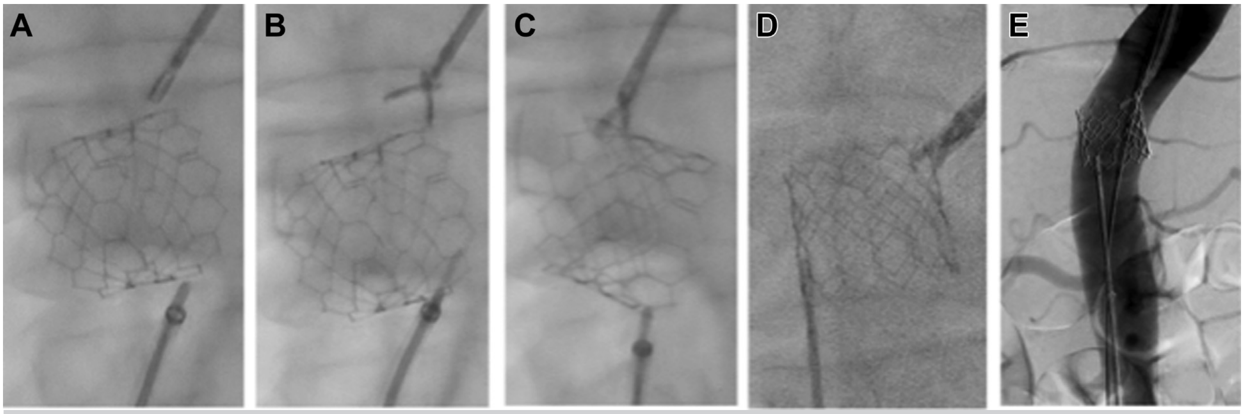

Fig 2. Fluoroscopy during thoracic endovascular aortic repair. **A-D,** Rotation of the embolized aortic valve into the correct position in the thoracic aorta. **E,** Angiogram showing proper positioning of the valve to allow for distal blood flow.

Fig 3. Completion aortogram. **A,** A thoracic stent graft was placed through the embolized valve. **B,** Stent-graft deployment. **C,** Completion angiogram demonstrating good flow to the distal aorta, including the celiac artery. **D,** Three-dimensional reconstruction of postoperative day 5 computed tomography angiogram.

Fig 4. Postoperative computed tomography angiogram showing cross-sectional areas of the aorta above the valve (**A**), at the level of the valve (**B**), and below the valve (**C**).

using the Edwards SAPIEN valve. Retrograde ventricular embolization mandates emergent surgery and carries high mortality. They cautioned that the guidewire should not be removed in the event of antegrade aortic embolization, because its presence will prevent the valve from rotating and occluding distal blood flow.[10] In such cases, the investigators suggested a large balloon should be inserted through the valve, because, once inflated, it might facilitate dragging the valve past the left subclavian artery where the diameters will be more compatible with the valve diameter.[10] Major open surgery will be required should the valve embolize into the aorta and rotate. However, alternative bail-out techniques might become relevant when a surgical option is not feasible.

Advances in technology and the availability of endovascular devices have allowed the consideration of endovascular surgery as a minimally invasive alternative to traditional open surgery.[11] At present, thoracic endografting is the standard of care for various aortic pathologies.[12,13] With consideration of our patient's comorbidities, body habitus, valve location, and required surgical procedure, we elected to favor an endovascular approach. An off-the-shelf definitive endovascular solution was selected, avoiding high-risk open aortic surgery and using the descending thoracic or infrarenal abdominal aorta as a landing zone to permanently anchor the embolized valve.

CONCLUSIONS

To the best of our knowledge, such an endovascular approach to manipulate, secure, and render harmless an embolized aortic valve after TAVR has not been previously described. Endo-graspers should be a part of the endovascular armamentarium to assist in valve manipulation. Aortic valve capture and fixation using an aortic stent-graft could be considered for patients who are unfit for open surgical repair.

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Submitted Jul 21, 2021; accepted Oct 14, 2021.