JACC: CASE REPORTS VOL. 30, NO. 8, 2025

CORONARY, PERIPHERAL, AND STRUCTURAL INTERVENTIONS

HOW WE DID IT

Buckling Under Pressure

Evolut FX Delivery System Malfunction and Failure to Recapture During TAVR

Ahmed Ghoneem, MD,[a] Mubashir Mumtaz, MD,[b] Paul D. Mahoney, MD[c]

ABSTRACT

OBJECTIVE We present a case of transcatheter aortic valve replacement in a 70-year-old woman with severe bicuspid aortic valve stenosis complicated by incomplete recapture of the Evolut valve and buckling of the delivery system.

KEY STEPS Our key steps included the following: 1) unsuccessful withdrawal of the buckled delivery system and valve into the inline sheath; 2) transradial snaring of the delivery system, followed by traction from both ends to reduce the amount of buckling; and 3) once elongated as much as possible, the malfunctioning Evolut delivery system and valve were removed as a unit over the wire.

POTENTIAL PITFALLS Aortic, iliac, or femoral injury: Reliant balloon was placed in the distal aorta use in case of arterial rupture.

TAKE-HOME MESSAGES The Evolut delivery system can buckle and accordion under tension in complex aortic anatomy. A technique of snaring from above and tension from below can mitigate the buckled area and allow removal of the damaged delivery system via the endovascular route. (JACC Case Rep. 2025;30:103197) © 2025 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

We present a case of transcatheter aortic valve replacement (TAVR) in a 70-year-old woman with severe bicuspid aortic valve stenosis complicated by accordion-like buckling of the valve delivery sheath, resulting in incomplete recapture of the self-expanding Evolut valve. This is a complication that has not been previously reported, and we report a novel approach to manage this complication.

TAKE-HOME MESSAGES

- The Evolut delivery system can buckle and accordion under tension in complex aortic anatomy. A technique of snaring from above and tension from below can mitigate a buckled Evolut Fx delivery system and allow system removal via the endovascular route.
- Vascular and/or injury are potential complications of removing a damaged delivery system using this technique; precautions to manage these serious complications should be taken.

CASE SUMMARY

The case was a 70-year-old woman with severe, symptomatic bicuspid aortic valve stenosis (mean

From the [a]Department of Cardiovascular Medicine, University of Pittsburgh Medical Center (Harrisburg), Harrisburg, Pennsylvania, USA; [b]Department of Cardiothoracic Surgery, University of Pittsburgh Medical Center (Harrisburg), Harrisburg, Pennsylvania; and the [c]Department of Cardiovascular Medicine, East Carolina University, Greenville, North Carolina, USA.

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

Manuscript received October 15, 2024; revised manuscript received November 12, 2024, accepted November 21, 2024.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2024.103197

ABBREVIATIONS AND ACRONYMS

RFA = right femoral artery

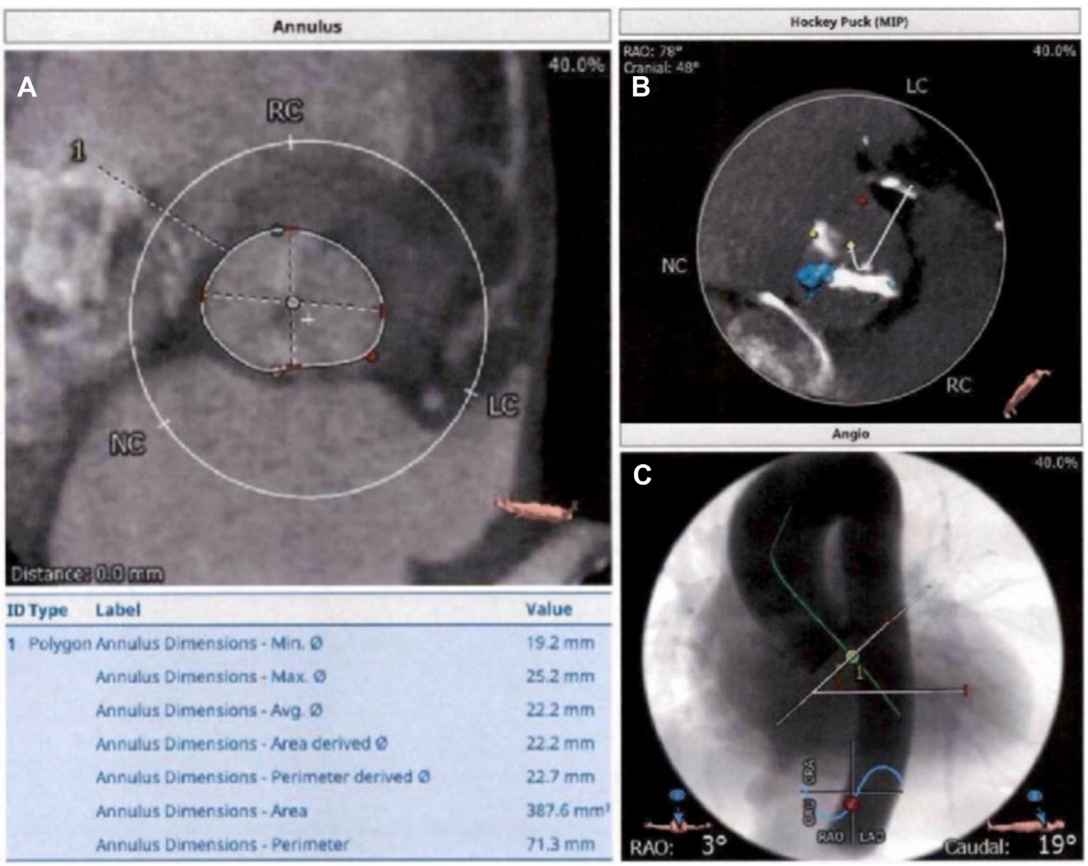
TAVR = transcatheter aortic valve replacement

gradient: 53 mm Hg, aortic valve area: 0.7 cm^2, dimensionless valve index: 0.21). Coronary angiography revealed non-obstructive coronary artery disease. Her Society of Thoracic Surgeons score was calculated at 4%. After a heart team evaluation and taking the patient's wishes to avoid surgical aortic valve replacement into consideration, she was deemed a candidate for TAVR. Computed tomography angiography assessment demonstrated a horizontal valve (with a perimeter of 71.3 mm and an area of 389 mm^2) and no obvious evidence of aortopathy (Figure 1). A 26 mm Evolut FX valve (Medtronic Inc) was planned.

PROCEDURAL STEPS

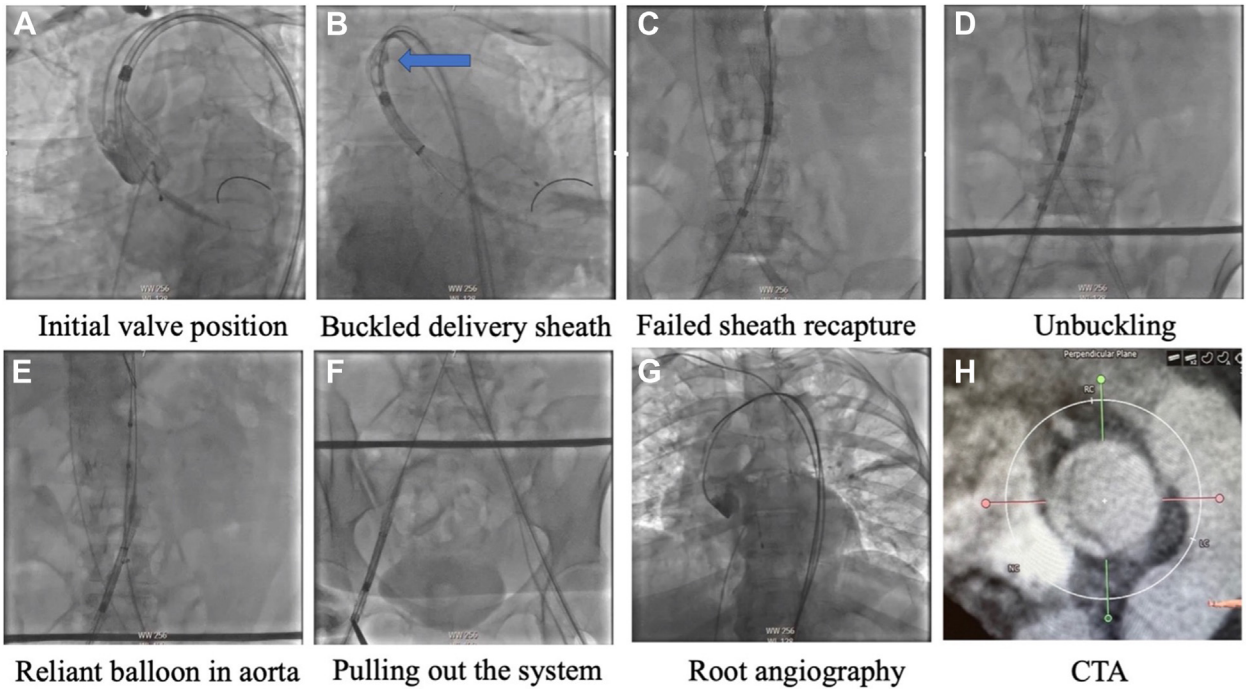
We proceeded with TAVR in a standard fashion. An 8-F arterial and a 7-F arterial sheath were placed in the right femoral artery (RFA)/left femoral artery, respectively, using a Seldinger technique under ultrasound guidance. A 6-F sheath was placed in the left femoral vein. A pigtail catheter was placed in the aorta. A temporary pacing wire was advanced to the right ventricle via the left femoral vein sheath and thresholds confirmed. A Perclose device (Abbott) was then deployed in the fashion of preclosure with knot tagged to the drape. A J wire was placed through the Perclose device, and a 14-F sheath was advanced

FIGURE 1 Case Plan



Computed tomography angiography showing (A) aortic annular dimensions, (B) bicuspid aortic valve anatomy with heavy calcifications, and (C) aortography showing a horizontal valve with no associated aortopathy. LC = left cusp; NC = non-coronary cusp; RAO = right anterior oblique; RC = right cusp.

VISUAL SUMMARY **Step-by-Step Sequence**



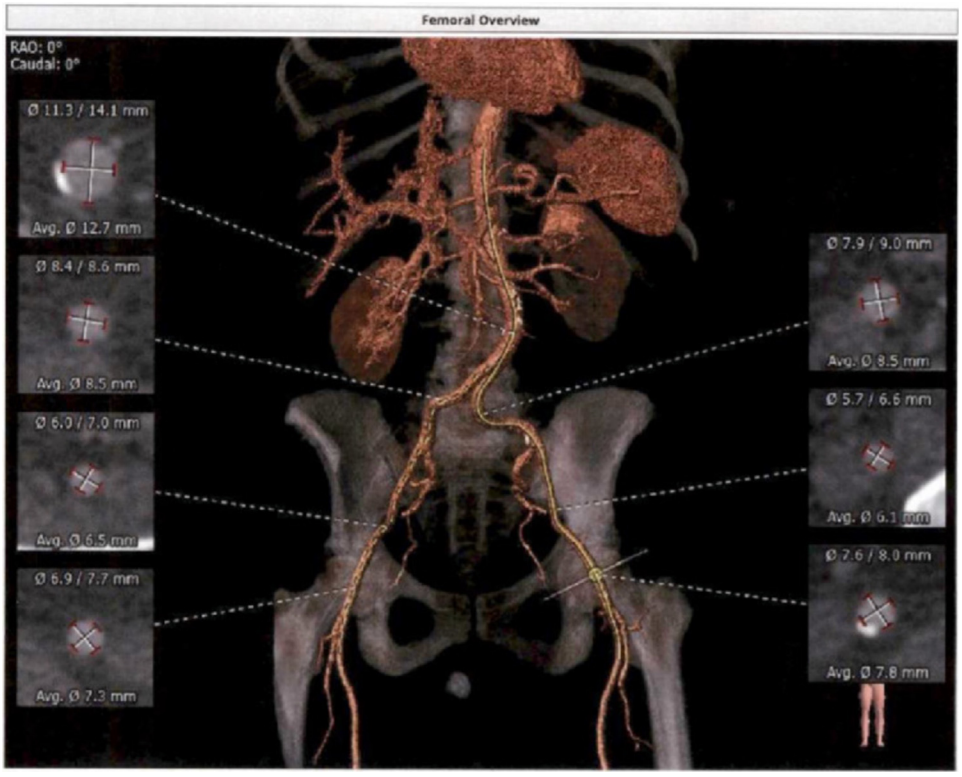
(A) Initial unsatisfactory valve position, after which we reattempted to recapture. (B) Buckling (accordioning) of the delivery sheath (arrow) with attempts to recapture. (C) Failed sheath recapture into the in-line sheath. (D) Snaring from above and traction from below to straighten the buckled sheath. (E) Reliant balloon in the distal aorta to use in case of catastrophic rupture. (F) Pulling out the delivery system and valve as a unit via the femoral artery. (G) Root angiography. (H) CTA showing a dissection flap at the sinotubular junction. CTA = computed tomography angiography.

through the RFA access site. An AL 1 catheter was placed over the J wire, and the aortic valve was crossed using a stiff wire. A Double Curved Lunderquist wire (Cook Medical) was placed in the left ventricle, and the catheter was removed. Balloon predilation was then performed using a 20-mm True Balloon (BD Medical).

Next, the native valve was crossed using the Evolut valve with some difficulty. Specifically, resistance was felt at the region of the sinotubular junction and at the valve requiring wire manipulation and increased forward pressure to cross the valve. The force required was not felt to be excessive, and we successfully crossed the valve within 30 seconds and therefore did not consider another balloon predilation. No deformities to the delivery system were noted at that point. The Evolut valve was then unsheathed slowly under direct fluoroscopic guidance using pigtail position and angiography as needed. Rapid pacing was performed. The valve was then unsheathed to the 2/3 position rapidly. Valve position was then assessed by aortography in the cusp overlap and 3 cusp views. The initial Evolut valve position was felt to be suboptimal when unsheathed to the 80% position, with the valve being aortic in position (Video 1). On attempting to resheath the valve, however, significant resistance was encountered with rotation of the handle, and the delivery system buckled and appeared as an accordion-like structure with about one-half of the Evolut valve outside the sheath (Video 2). We attempted to overcome the resistance with some additional force; however, clicking was heard and no further attempts to resheath the valve were made.

With careful traction, we were able to bring the entire system back into the descending aorta. We then tried withdrawal of the buckled delivery system to a more distal position and pulled the valve into the inline sheath, but this was unsuccessful and caused

FIGURE 2 **Computed Tomography Angiography of the Aorta, Iliac, and Femoral Arteries**



Favorable femoral and iliac arterial anatomy with a minimum diameter of 6 mm in the right external iliac artery.

more transient bunching of the delivery sheath at the inline sheath with retraction (Video 3). It was clear we would not be able to recapture the exposed valve into the inline sheath. Given that the iliac and femoral arterial anatomy was favorable with minimal disease (**Figure 2**), we decided to attempt removal of the entire system while minimizing the risk of iliac/femoral artery disruption.

We therefore advanced a 6-F multipurpose guide to the descending aorta via right radial access. Using a 30-mm gooseneck snare, we snared the Evolut sheath delivery system to anchor it, then gently applied traction from both ends to reduce the amount of buckling and elongate the delivery system (Videos 4 and 5). Once we had elongated the delivery system as much as able, we replaced the snare with a pigtail catheter for immediate angiography after removal of the Evolut valve/delivery system complex. Given the risk that attempted percutaneous removal of the system could lead to iliofemoral disruption, we also upsized the left femoral sheath to 14 F, and took a 12-F 20-mm Reliant balloon (Medtronic) to the distal aorta for aortic occlusion in case of catastrophic rupture (Video 6).

Under fluoroscopic and tactile guidance, we then carefully removed the malfunctioning Evolut delivery system and valve as a unit over the wire. This came out of the femoral access site smoothly (Video 7). We immediately replaced an 18-F right femoral sheath. Distal aortography confirmed patent femoral arteries bilaterally (Video 8). The RFA 18-F sheath was then removed, and a Perclose knot was delivered to the arteriotomy. The left femoral artery 14-F sheath was removed next, and a Perclose knot was placed (**Figure 3**).

POTENTIAL PITFALLS

It is important to recognize that the incompletely sheathed valve was flaring out of the delivery catheter, which created very sharp edges on the system.

We therefore thought that attempting to remove the system en bloc via the femoral arteries would potentially cause serious vascular injury (aorta or iliac/femoral arteries), even with a relatively straight catheter despite a buckled delivery system. This snaring technique helped with resheathing as much of the valve as possible, reducing the profile of the system before system removal.

Repeated attempts at recapturing the valve could potentially result in intimal tears in the aorta, which can progress to catastrophic aortic dissection. In fact, root aortography in our case showed a small intimal flap at the level of the sinotubular junction, which was also confirmed with a computed tomography angiogram (Video 9). However, we think the intimal tear could have occurred with forward pressure to cross the valve initially rather than the attempts at valve recapture, evidenced by the retrograde appearance of the dissection.

The patient remained hemodynamically stable and asymptomatic throughout the entire procedure. We elected to abort the procedure and the patient successfully underwent elective aortic root repair and aortic valve replacement 3 days later. At 1-year follow-up, the patient continues to do well, reporting no heart failure symptoms, and the surveillance echocardiogram revealed a well-functioning prosthetic aortic valve.

Although buckling of the delivery system is a previously unreported complication, it may be more frequently encountered in the future with the expanding indications of TAVR in patients with hostile aortic valve anatomies. We would therefore recommend this technique of snaring and traction in similar situations to overcome the buckled catheter and allow safe extraction of the system rather than valve deployment at an inadequate depth, or possibly, in the aorta. This technique could potentially be useful in other cases of failure to recapture the valve, such as a malfunctioning grip handle, inappropriate valve loading, or severe valve infolding.

CONCLUSIONS

This case highlights a previously unreported complication of the Evolut Fx delivery system, where it can buckle, or accordion, under tension in complex aortic anatomy. This can lead to inability to resheath the valve in the body, create sharp wings on the catheter, and increase the risk for vascular injury. We report the successful use of a technique of snaring from above and tension from below to mitigate the buckled area and remove the damaged delivery system via the endovascular route. This technique has not been previously reported.

FIGURE 3 Equipment List

Equipment List

A) TAVR
- Ultrasound machine (Philips Healthcare, USA)
- Micropuncture needle and wire
- .035 J wire
- 7F sheath - LFA
- 8F sheath, followed by 14 F sheath - RFA
- 6F sheath - LFV
- 1 Proglide (Abbott Vascular, USA) - RFA
- AL 1 catheter
- Pigtail catheter
- Ventricular pacing catheter
- Double-curved Lunderquist wire (Cook Medical, USA)
- True Balloon 20 mm (BD Medical, USA)
- Evolut FX delivery catheter system with inline sheath 14F

B) Snaring the delivery system
- 6F sheath - right radial artery
- 6F Multipurpose catheter
- 30 mm Amplatz Gooseneck snare (Medtronic, USA)

C) Mitigating the risk of vascular injury
- 14F Sentrant introducer sheath - LFA (Medtronic, USA)
- Reliant Balloon, 20 mm (Medtronic, USA)
- 18F Sentrant introducer sheath - RFA (Medtronic, USA)
- 2 Proglide (Abbott Vascular, USA) - LFA

LFA = left femoral artery; LFV = left femoral vein; RFA = right femoral artery; TAVR = transcatheter aortic valve replacement.

FUNDING SUPPORT AND AUTHOR DISCLOSURES

Dr Mahoney has served as a consultant for Medtronic and Edwards Lifesciences. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS FOR CORRESPONDENCE: Dr Ahmed Ghoneem, Department of Cardiovascular Medicine, University of Pittsburgh Medical Center (Harrisburg), 205 South Front Street, Brady Hall, Suite 3C, Harrisburg, Pennsylvania 17105, USA. E-mail: ghoneema@upmc.edu. X handle: @a_h_ghoneem.

KEY WORDS bicuspid, complication, Evolut, TAVR

APPENDIX For supplemental videos and a video summarizing the case, please see the online version of this paper.