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Imaging and Case Report

Embolization of a Fully-Deployed Transcatheter Aortic Valve Implant Caused by Chest Compression During Cardiopulmonary Resuscitation

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We report a case of a 74-year-old woman who developed an embolized transcatheter aortic valve implant after cardiopulmonary resuscitation (CPR), which is an unexpected sequel of CPR.[1] A second transcatheter heart valve was implanted, capturing the distal frame of the embolized valve (valve-in-valve strategy). Moreover, this case highlights the feasibility, safety, and efficacy of using this approach to avoid the need for surgical bailout.

Case report

A 74-year-old woman presented with exertional shortness of breath caused by a low gradient, normal ejection fraction, severe aortic stenosis. She was functionally limited, which favored a transcatheter aortic valve replacement (TAVR) consensus during the heart team discussion. Given the area and perimeter of the annulus, a 26-mm Evolut Pro Plus valve (Medtronic) was deemed appropriate. A 14F Sentrant sheath (Medtronic) was placed in the right femoral artery, and a 6F right radial artery sheath enabled placement of a 6F pigtail catheter in the noncoronary cusp for aortic root aortograms. An Amplatz-1 catheter was used to cross the native aortic valve (AV), with the placement of a regular SAFARI wire (Boston Scientific). The Evolut valve was delivered to the AV through the delivery catheter system with an inline sheath using commissural alignment, with pacing at 140 bpm during the later stages of valve deployment. A 3-mm depth deployment was planned. After successful valve deployment, the delivery system catheter was removed, with reinsertion of the 14F Medtronic sheath over the SAFARI wire in situ (Figure 1A and Supplemental Videos 1 and 2). There was a drop in AV gradients between pre-TAVR and post-TAVR from 34 to 0 mm Hg with negligible aortic regurgitation (AR) (Figure 1B, C).

The procedure was deemed successful, and the plan had been to end with an aortogram to document valve expansion and lack of paravalvular leak. The left ventricular (LV) pigtail was removed over a 0.035-inch exchange J wire; unfortunately, it pulled out the 14F Medtronic sheath. To reinsert the sheath, the dilator was reintroduced, and the unit was pushed in without initial fluoroscopic guidance. After resistance was noted, an angiographic image revealed perforation of the common femoral artery (CFA), with the sheath-dilator having transected the femoral artery and residing outside of the arterial structures (Figure 1D). The 0.035-inch J wire did not provide the same stiffness as the SAFARI wire to keep the sheath-dilator from being directed toward the wall, resulting in perforation.

The patient became hypotensive and went into hemorrhagic shock and cardiac arrest. CPR was started with immediate intubation and aggressive fluid and inotrope resuscitation. The right external iliac artery was stented with two 6 $\times$ 37-mm stent grafts to seal the CFA perforation. Final angiographic cine imaging showed good sealing of the perforation with no residual leak (Figure 1E).

The patient regained return of spontaneous circulation (ROSC) but continued to be hypotensive even with vasopressor support. A recheck aortogram showed embolization of the Evolut valve, with occlusion of the coronary arteries and concomitant AR (Figure 1F and Supplemental Video 3). Then, an EN-Snare was inserted from the left femoral artery (LFA) to snare the embolized valve to the ascending aorta and re-establish coronary blood flow. A second 26-mm Evolut Pro Plus valve was crimped and prepared for delivery from the LFA. Another 14F sheath was inserted from the LFA with an Amplatzer Superstiff wire, and the LV was re-entered using an Amplatz-1 catheter. A 6F pigtail catheter was used to place a SAFARI wire into the LV while making sure that both the wire and catheter passed within the embolized valve in the ascending aorta. Attempts at delivery of the second Evolut valve were thwarted by its interaction with the first deployed valve, pushing the latter down back to the coronary sinuses. Therefore, the embolized valve had to be held in place with the EN-Snare, whereas the second valve was positioned within the LV annulus (Figure 1G, H and Supplemental Videos 4 and 5). Valve deployment and release was performed using LV pacing at 140 bpm. This valve was postdilated with a 21-mm Crystal balloon to obtain optimal expansion and decrease paravalvular leak. Repeat hemodynamic assessment showed no AV gradient, and an aortogram showed trivial AR and excellent coronary blood flow (Figure 1I, J and Supplemental Video 6).

Keywords: aortic stenosis; cardiopulmonary resuscitation; embolization; Evolut valve; transcatheter aortic valve replacement.
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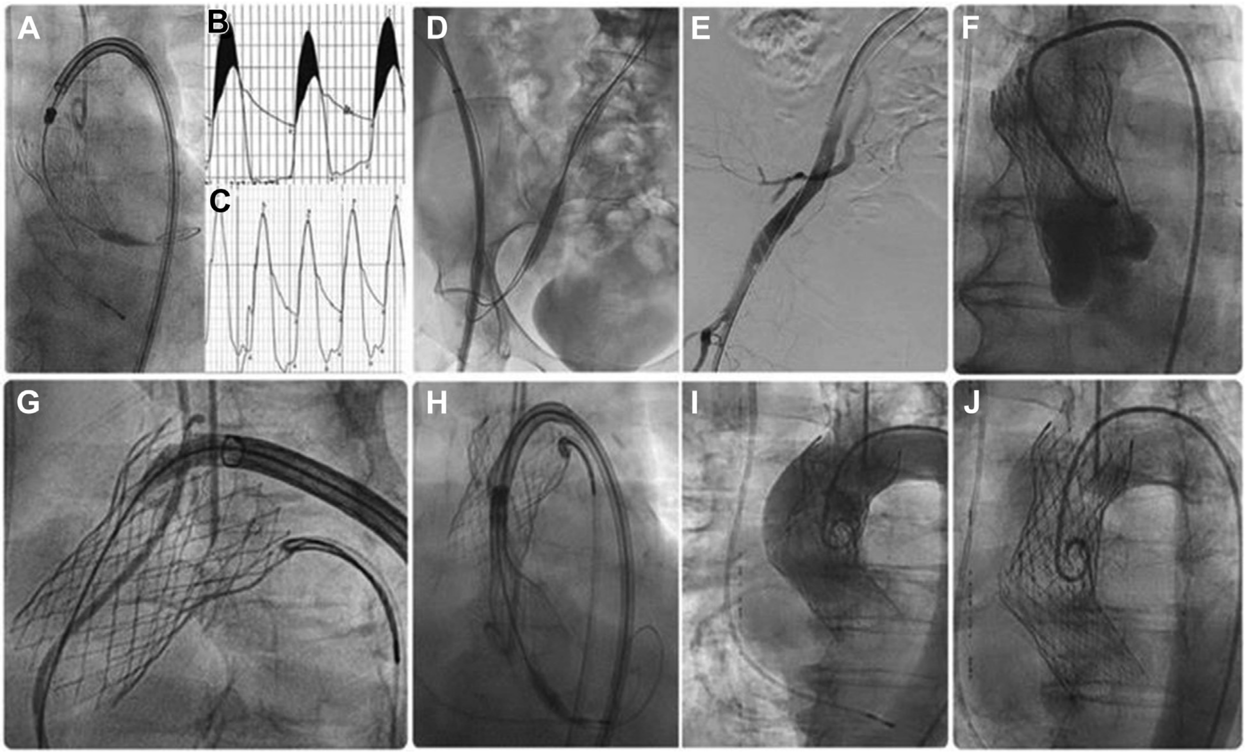

Figure 1.
(**A**) Successful deployment of a 26-mm Evolut Pro Plus valve. (**B, C**) Instant drop in AV gradients between pre-TAVR and post-TAVR from 34 to 0 mm Hg. (**D**) An angiographic image revealed perforation of the common femoral artery with the sheath-dilator having transected the femoral artery and residing outside of the arterial structures. The right external iliac artery was ballooned with an 8- × 40-mm Mustang balloon to tamponade. (**E**) Final angiographic cine imaging showed good sealing of the perforation with two 6- × 37-mm stent grafts with no residual leak. (**F**) A recheck aortogram showed embolization of the Evolut valve, with occlusion of the coronary ostia. (**G**, **H**) Snaring the embolized valve to the ascending aorta with EN-Snare while the second valve was positioned within the LV annulus. (**I**) Final aortogram showed excellent valve expansion and coronary blood flow. (**J**) Final result without contrast, demonstrating the double-valve capture technique.

The patient remained unresponsive and comatose. Her stay was also complicated by sepsis and ventilator-associated pneumonia. She died of sepsis 7 weeks after the procedure.

Discussion

In our case, the patient underwent CPR, including chest compressions, owing to iatrogenic CFA perforation complicated with a hemorrhagic shock. The high quality and forceful chest compression exposed the Evolut valve to extreme mechanical force, which caused embolization of the valve and, subsequently, a severely ischemic myocardium because the embolized valve occluded the coronary ostia combined with a torrential AR. Those serial complications together made a sustained ROSC extremely challenging.

Our case of self-expanding TAVR prosthesis embolization was managed using a strategy using the proximal end of a second valve to capture the distal end of the embolized one (double-valve capture technique). By fixing the first valve within the second one, the risk of additional migration was mitigated.

The causes of device embolization are classified as procedural and preprocedural causes. The latter include anatomic causes, such as sizing errors, bicuspid AV, root anatomy (horizontal aorta), and absence of calcifications. Procedural causes are subdivided into those related to positioning errors and those related to deployment issues.[2] Our case should alert cardiologists to the fact that CPR may cause postprocedural embolization.

To our knowledge, this is the first reported case of an embolized transcatheter heart valve prosthesis after CPR. Nevertheless, there have been reports of deformed valves after chest compression or embolized valves secondary to suboptimal deployment but not after confirmed successful replacement with a good result.[3]

Conclusions

This case illustrates that TAVR embolization following chest compression after successful replacement is a possible complication. Care must be taken when providing CPR to patients with AV bioprostheses, and instant imaging is crucial in case of unexplained refractory cardiac arrest or after ROSC achievement to evaluate valve position and expansion.

Declaration of competing interest

The authors declared no potential conflict of interest with respect to the research, authorship, and/or publication of the article.

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Ethics statement and patient consent

This case report was performed in accordance with the relevant ethical and institutional guidelines with appropriate consent.

Supplementary material

To access the supplementary material accompanying this article, visit the online version of the *Journal of the Society for Cardiovascular Angiography & Interventions* at 10.1016/j.jscai.2023.100966.

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