

## Complete Crush of a Balloon-expandable Bioprosthesis After Prolonged Cardiopulmonary Resuscitation

Tobias Spangenberg, MD; Christian Frerker, MD; Ralf Bader, MD; Ulrich Schäfer, MD

We report on a case of an 88-year-old woman with severe aortic stenosis. Concomitant morbidities consisted of severe atherosclerosis, a large thoracoabdominal aortic aneurysm, atrial fibrillation, malignancy of the rectum with termino-terminal descenderectomy, chronic renal insufficiency, and adipositas (body mass index, 31.1). Due to the high surgical risk (EuroSCORE II, 12.3%), the patient was considered to be a good candidate for transcatheter aortic valve implantation (TAVI). In an interdisciplinary approach the patient underwent transapical TAVI (Edwards Sapien XT, 26 mm) due to anatomic reasons (horizontal aorta) in addition to a large thoracoabdominal aneurysm that was mostly covered by thrombus formation (Figure A, B). Due to the relevant comorbidities, we decided to embed the TAVI as part of a staged procedure treatment strategy. The procedure went exceptionally well with a wire position that was kept at all times out of the thoracic aneurysm and was followed by a benign postinterventional course. As a sign of acute benefit, the impaired renal and respiratory functions stabilized within the next few days, and the patient was mobilized on the ward. On the fifth postoperative day, the patient suddenly complained of excessive back-pain and collapsed with pulseless electric activity. Invasive blood pressure readings showed a constant decline in pressure amplitude, while chest compressions took place. After pneumothorax and pericardial tamponade had been excluded, we suspected aneurysm rupture as the underlying diagnosis. Resuscitation efforts were terminated after 30 minutes of pulseless electric activity. To verify the clinical hypothesis, an autopsy was performed, presenting 2 major findings. First, cause of death was most likely a ruptured aortic aneurysm, but second the previously implanted aortic valve prosthesis showed complete deformation, while still in correct anatomic position (Figure C, D).

### Discussion

Minimal invasive (transapical/transfemoral) aortic valve replacement has become a promising treatment modality for patients in the surgical high-risk population. The clinical benefit with TAVI has been repeatedly demonstrated, and TAVI is currently thought to be an alternative to conventional surgery in these patients.<sup>1</sup>

In our case the patient underwent cardiopulmonary resuscitation, including chest compressions due to a ruptured aortic aneurysm. Most likely, there was a chronic dissection present, which may have been exposed to a higher pulse pressure after TAVI, ultimately leading to complete rupture and death in this particular patient. In addition, the prolonged cardiopulmonary resuscitation with a Sapien valve unfavorably sitting directly opposite to the spine (Figure) in a patient with hemorrhagic shock and thus collapsing ventricles and aorta may have exposed the bioprosthesis to extreme mechanical force. Nevertheless, even with a reversible cause of cardiac arrest, the deformed prosthesis would have made a return of spontaneous circulation highly unlikely.

The implanted prosthesis in our case contained a cobalt-chromium frame providing high radial strength but no characteristics of shape memory alloys. Other available prosthesis types contain a nitinol frame. Nitinol is one of the most common representatives of shape memory alloys. Whether a nitinol frame with a high radial-strength section and a supra-valvular low radial-strength section would have resisted the repetitive mechanical compressions remains unknown, but is worthy of further biomechanical investigations.

In this regard, the concept of even newer TAVI devices with very little metal may draw specific attention to circumstances in which mechanical force is applied to the chest (airbags, cardiopulmonary resuscitation, etc). Whether external force (eg, chest compressions), in general, can lead to a crush of aortic valve prosthesis or if the specific anatomic alignment in our case is to be held responsible remains unclear and necessitates further investigation. Until clarification is provided, awareness-enhancing precautions (ie, chest x-ray) and perhaps even earlier use of alternative resuscitation measures (ie, extracorporeal assist) should be considered.

On retrospect, the patient was an inappropriate candidate for TAVI with her known large thoracoabdominal aneurysm. Clearly, surgical aortic valve replacement sparing the thoracoabdominal aneurysm would have not prevented this fatal outcome, but a combined surgical or even interventional approach in that high-risk patient would have been a major task.

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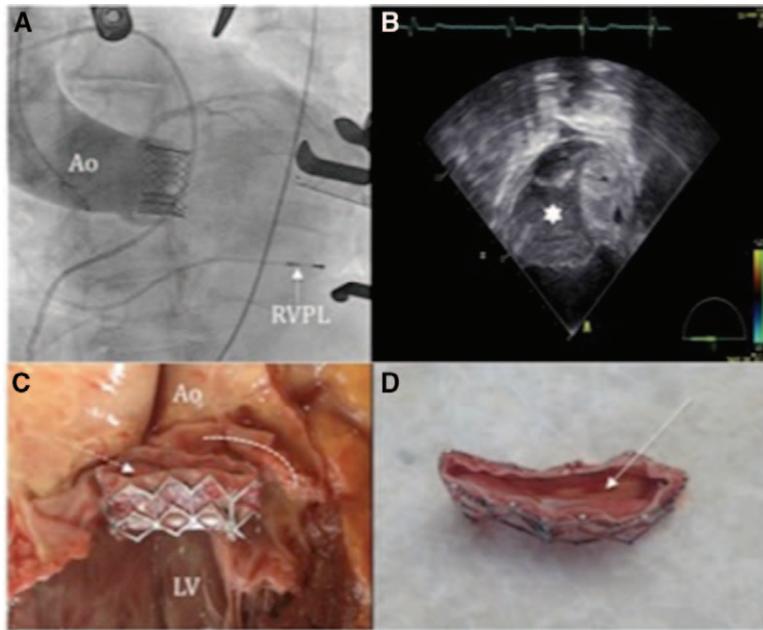
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**Figure.** Intraprocedural images (A,B) and post-mortem exposition (B,C). Asterisk indicates thoracoabdominal aneurysm covered by thrombus formation; dashed line, native aortic valve; dashed arrow, crushed prosthesis in situ (slightly displaced for didactic purposes); arrow, explanted crushed prosthesis; Ao, aorta; LV, left ventricle; and RVPL, right ventricular pacing lead.

To our knowledge, this is the first reported case of a deformed aortic valve prosthesis after cardiopulmonary resuscitation. Nevertheless, there have been reports on deformed pulmonary valves, coronary stents, or stentgrafts after chest compressions.<sup>2-4</sup> Thus, further investigations to increase the radial force or crush resistance of current and future TAVI devices are warranted, especially in view of endeavors to extend minimal invasive aortic valve replacement therapies to healthier patient populations.

### Disclosures

None.

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**KEY WORDS:** atherosclerosis: other arteriosclerosis ■ hypertension: valvular heart disease ■ peripheral vascular disease ■ treatment: catheter-based coronary and valvular interventions: other ■ treatment: CPR and emergency cardiac care

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