Article published online: 2023-03-20

Hybrid Thoracic Aortic Repair and Aortic Valve-In-Valve Replacement for Chronic Type A Dissection

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Thorac Cardiovasc Surg Rep 2023;12:e17–e20.

Abstract

We describe a case of hybrid total thoracic aortic repair and valve-in-valve transcatheter aortic valve replacement in a high-risk patient with complicated chronic type A dissection and severe prosthetic aortic stenosis. The patient underwent a three-stage-procedure including aortic arch debranching, thoracic endovascular aortic repair of the ascending aorta, aortic arch and descending thoracic aorta, and direct aortic valve-in-valve replacement using transcatheter heart valve. The details of the procedures are described with a discussion of the challenges and the decision-making process.

Keywords

- heart valve
- transapical
- percutaneous
- endovascular aortic repair/stents
- hybrid aortic repair
- aortic disease

Introduction

Open surgery is considered the standard of care for patients with ascending aortic pathology. However, there are several reports on using thoracic endovascular aortic repair (TEVAR) in high-risk patients who may not tolerate open surgical intervention.[1–6] Hybrid aortic repair is advocated whenever an open surgical repair is high risk or contra-indicated, and TEVAR is not feasible due to anatomical complexity. The coexistence of severe aortic stenosis with the complex proximal aortic disease requires extensive discussion and appropriate planning by the heart team members.

In this case, we report a hybrid total thoracic aortic repair and valve-in-valve (V-I-V) transcatheter aortic valve replacement (TAVR) in a high-risk patient with complicated chronic type A dissection and severe prosthetic aortic stenosis.

Case Report

This is a case of a 74-year-old female patient who presented with shortness of breath on exertion and upper back pain. Two years prior to her current presentation, she had acute type A aortic dissection for which she underwent the Bentall procedure with a bioprosthetic valve (Mitroflow size 23) in another institution. Computerized tomography (CT) done upon presentation showed a remnant dissected ascending aorta with a dissection flap extending down to the aortic bifurcation. It also showed a large aneurysm starting at the base of the left subclavian artery and extending to mid descending thoracic aorta measuring 7.8 cm at maximal diameter (►**Fig. 1**). There was severe calcification at the aortoiliac bifurcation with severe tortuosity in the iliac and femoral vessels. Echocardiogram showed severe aortic stenosis with a mean gradient of 55 mm Hg. Based on the clinical presentation and the imaging findings, the ideal

received
November 25, 2022
accepted
January 30, 2023

DOI https://doi.org/10.1055/s-0043-1764299.
ISSN 2194-7635.

Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

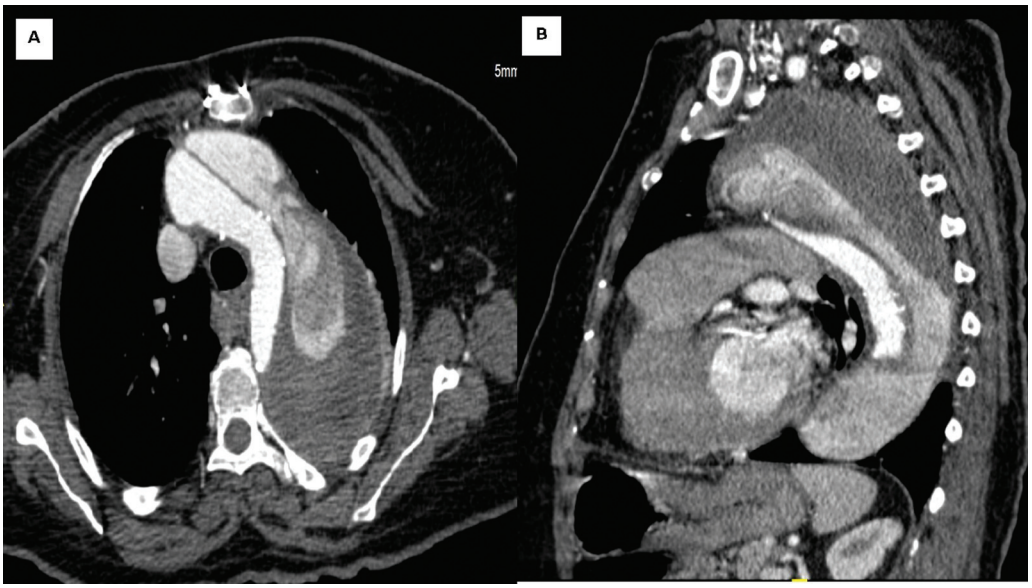

Fig. 1 CT Aortogram of the chest demonstrating the dissected thoracic aorta with a large aneurysmal cavity of the distal arch and proximal descending aorta. (**A**) Axial view. (**B**) Sagittal view.

approach to manage this patient would be a redo sternotomy, redo Bentall procedure, aortic arch replacement, and elephant trunk under deep hypothermic circulatory arrest followed by a second procedure for elephant trunk completion. Given the patient age and comorbidities, we entertained a hybrid approach including redo sternotomy with aortic arch debranching from the ascending aortic graft followed by TEVAR of the ascending aorta, aortic arch and descending thoracic aorta, and finally direct trans-aortic V-I-V TAVR.

Initially, the patient underwent redo sternotomy and cardiopulmonary bypass was established using right axillary arterial cannulation and direct right atrial venous cannulation. The dissected native aorta was clamped 2 cm below the innominate artery, and a trifurcated graft was sutured to the right side of the Bentall graft 2 cm above the origin of the implanted right coronary artery. The distal anastomoses of the debranching limbs to innominate and left common carotid arteries were performed off bypass. Finally, the origin of both debranched vessels were ligated. The third limb of the trifurcated graft was tied and left in the mediastinum as an access for the future planned TAVR procedure (►**Fig. 2**).

One week later, the patient underwent TEVAR through a cut down on the right femoral artery. Three overlapping endovascular stent grafts size 32 ×142 mm (Cook Zenith TX2 endovascular graft) were deployed starting just above the level of the debranching graft and covering the whole thoracic aorta down to 4 cm above the origin of the celiac artery (►**Fig. 3A**). Postoperative CT scan showed complete thrombosis of the false lumen in the thoracic aorta proximal to the distal landing zone (►**Fig. 3B**).

Four days later, the patient underwent resternotomy and the third limb of the trifurcated graft was retrieved and was used as an access for direct aortic V-I-V TAVR. Size 26 Edward's Sapien 3 valve was deployed inside the previous valve over a Safari wire (►**Fig. 4**) without complications and there was no evidence of any paravalvular leak. The patient was later discharged home in stable condition after 3 weeks in the hospital.

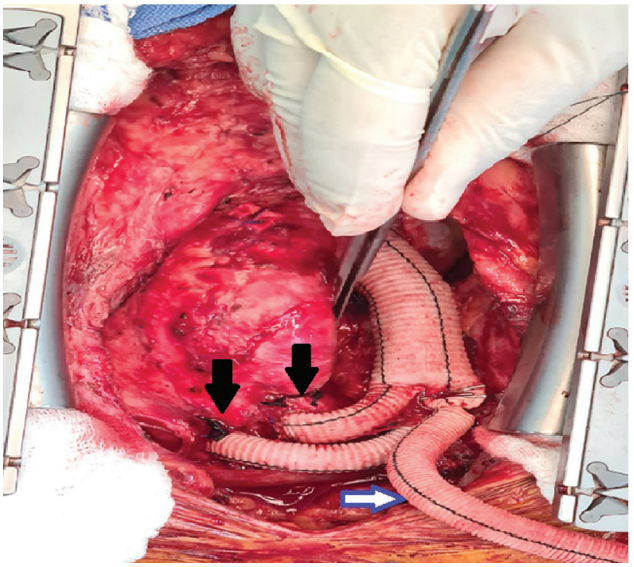

Fig. 2 Operative image showing the debranching graft with two limbs bypassing the innominate artery and left common carotid artery (black arrows) and the third limb reserved for future direct transaortic TAVR (*blue arrow*).

Discussion

We presented here a very complicated case with complex anatomy in a high-risk patient for which the hybrid approach represents the safest approach. To our knowledge, this is the first reported case of zone zero TEVAR followed by V-I-V TAVR in the setting of chronic type A dissection.

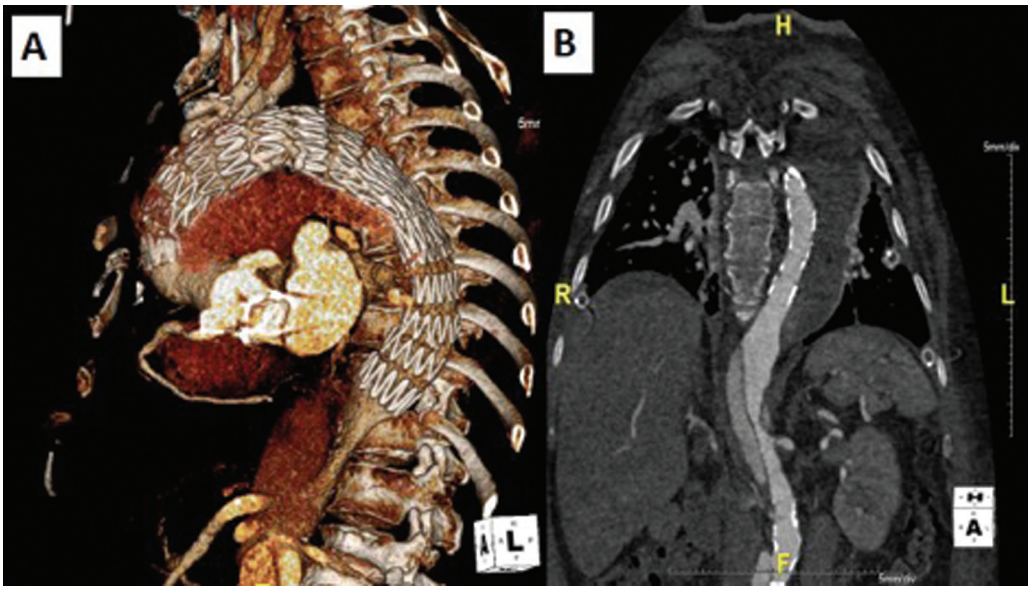

Fig. 3 Postdeployment of three overlapping TEVAR grafts. (**A**) 3D reconstruction of the thoracic aorta post TEVAR. (**B**) Coronal reconstruction of the thoracic aorta showing complete thrombosis of the false lumen in the thoracic aorta proximal to the distal landing zone.

The first debranching procedure was performed on-pump because the Bentall graft was short measuring only 4 cm above the site of the implanted right coronary artery that made the application of the side biting clamp very difficult. We elected not to bypass the left subclavian artery because it was deep in the left thoracic cavity and it was adherent to the large thoracic aneurysm of the distal arch.

For the second procedure, there were several challenges that required appropriate planning and adequate experience.

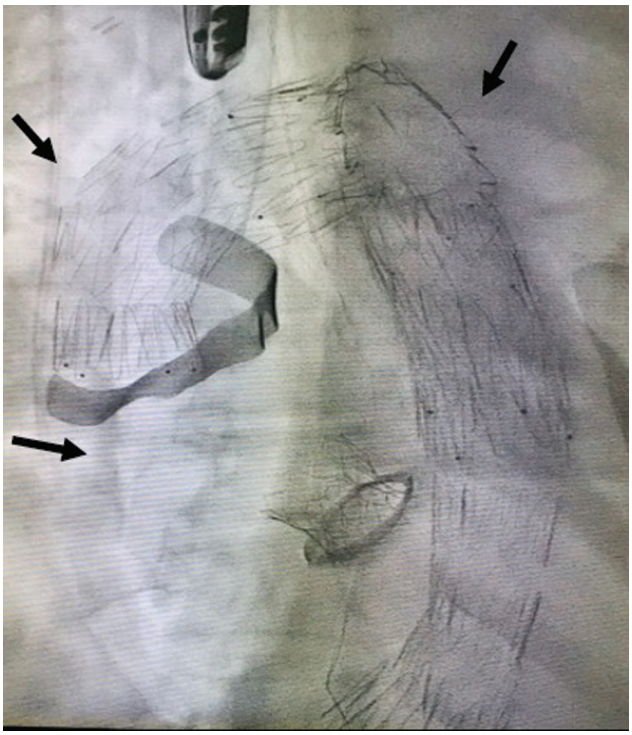

Fig. 4 Fluoroscopic image post V-I-V TAVR deployment showing the different angles of the thoracic aorta (*black arrows*).

The first challenge was the chronically dissected aorta with multiple fenestrations that necessitated the use of intravascular ultrasound to confirm that the TEVAR introducing system was traversing the true lumen through its whole course. The second challenge was the extensive calcification and tortuosity in the femoral and iliac vessels that required careful insertion and monitoring of the stent grafts during insertion. The third challenge was the aortic configuration that consisted of three angles through its thoracic course as a result of the aortic enlargement and elongation (►**Fig. 4**). These three angles caused a significant resistance and loss of system energy during the insertion of the three stent grafts. One of the options that we discussed for this patient was the use of a custom-made double or triple-branched device for the aortic arch. However, this option, although not available in our country, was not technically feasible given the large size of the aortic arch false lumen, which in cases of chronic dissection could complicate the deployment of the branched stent and the alignment of its branches in the corresponding arch vessels. We thought that this option will carry a higher risk of technical failure and type 2 and 3 endo-leaks.

In our experience, the thrombosis of the false lumen in the thoracic aorta in chronic dissection cases is associated with stabilization of the size of the thoracic aneurysm and possibly regression in most of the cases. Follow-up with a CT aortogram is very important every 6 months to detect any future progression, usually in the abdominal non-stented aorta. If the abdominal aorta progresses in the future, then our preferred approach would be an open surgical repair of the abdominal aorta with direct anastomosis to the lower part of the stent. Alternatively, in very high-risk patients, we may elect to perform visceral and renal artery bypasses from the femoral or iliac arteries and then perform endovascular aortic repair of the whole abdominal aorta.

The main challenge for the third procedure was the access site choice for TAVR. We thought that the safest option would be direct aortic access through the side graft that was planned during the initial stages of the intervention. We did not use the self-expanding transcatheter heart valve (THV) (Evolut R/PRO) because of its tall stent frame that could disrupt the debranching graft anastomosis.

Conclusion

Hybrid thoracic aortic repair is safe in high-risk patients with highly complex aortic anatomy. Careful discussion and planning by heart team members is crucial for the success of these procedures.

Authors' Contributions

T.B.A was responsible for conception and design of the study, literature review, analysis and interpretation of data, research investigation and analysis, drafting of the manuscript, revising and editing the manuscript critically for important intellectual contents, and final approval of the version to be published.

F.K.A. was responsible for conception and design of the study, literature review, analysis and interpretation of data, research investigation and analysis, drafting of the manuscript, revising and editing the manuscript critically for important intellectual contents and final approval of the version to be published.

A.A. was responsible for conception and design of the study, literature review, analysis and interpretation of data, research investigation and analysis, drafting of the manuscript, revising and editing the manuscript critically for important intellectual contents, and final approval of the version to be published.

T.A. was responsible for conception and design of the study, literature review, analysis and interpretation of data, research investigation and analysis, drafting of manuscript, revising and editing the manuscript critically for important intellectual contents, and final approval of the version to be published.

A.A. was responsible for conception and design of the study, literature review, analysis and interpretation of data, research investigation and analysis, drafting of manuscript, revising and editing the manuscript critically for important intellectual contents, and final approval of the version to be published.

M.A. was responsible for conception and design of the study, literature review, analysis and interpretation of data, research investigation and analysis, drafting of the manuscript, revising and editing the manuscript critically for important intellectual contents, and final approval of the version to be published.

F.Z. was responsible for conception and design of the study, literature review, analysis and interpretation of data, research investigation and analysis, drafting of manuscript, revising and editing the manuscript critically for important intellectual contents, and final approval of the version to be published.

Y.A. was responsible for conception and design of the study, literature review, analysis and interpretation of data, research investigation and analysis, drafting of manuscript, revising and editing the manuscript critically for important intellectual contents, and final approval of the version to be published.

A.E. was responsible for conception and design of the study, literature review, analysis and interpretation of data, research investigation and analysis, drafting of the manuscript, revising and editing the manuscript critically for important intellectual contents, and final approval of the version to be published.

Funding

None.

Conflict of Interest

There has been no duplicate publication or submission of this manuscript elsewhere. All authors have read and approved the manuscript. There is no ethical problem or conflict of interest to be declared for any of the coauthors.

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