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Case Report

The Brink of the Abyss: From Transcatheter Aortic Valve Implantation, to Impella, to Left Ventricular Assist Device Destination Therapy

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Abstract

Acute valvular emergencies are common causes of cardiogenic shock. Patients with critical aortic pathologies causing shock frequently undergo percutaneous interventions for valve replacement. However, in cases of persistent cardiogenic shock after valve replacement, there are limited options for further mechanical support. In this case study, we report a patient with a prior history of aortic valve replacement who presented in cardiogenic shock. After a transcatheter aortic valve-in-valve replacement, he remained in persistent shock with worsening clinical parameters requiring escalating inotropic and vasopressor support. With input from a multidisciplinary care team, an Impella 5.5 (Abiomed, Inc.) was placed through the valve for mechanical circulatory support, ultimately serving as a bridge to a durable left ventricular assist device as destination therapy. This technically challenging approach was successful, and the patient was discharged to acute rehabilitation with improved symptoms.

Keywords: cardiogenic shock, transcatheter aortic valve implantation, Impella

Background

Mortality from cardiogenic shock (CS) remains unacceptably high, with rates among the most serious cases reaching almost 70%.¹ One of the most common causes of CS is acute valvular emergency, which represents up to 8% of all cardiac intensive care unit (CICU) admissions.² Critical aortic stenosis (AS) is a frequently encountered valvopathy in the CICU and is often fatal without aortic valvuloplasty or definitive surgical or percutaneous intervention to replace the valve.³ In patients with significant medical comorbidities who are deemed high surgical risk, transcatheter aortic valve implantation (TAVI) is the preferred method of intervention.⁴

Despite advances in technology and technique, TAVI remains technically challenging.⁵ Data from the Bern registry, a

national prospective cohort of patients undergoing TAVI, showed that 11.6% of patients did not have technical success according to the Valve Academic Research Consortium-3 criteria.⁵ Thus, when complications arise, it is important to have bailout strategies in place. One common strategy, if shock persists despite inopressor therapy, is the use of temporary mechanical circulatory support (MCS) as bridge therapies, such as veno-arterial extracorporeal membrane oxygenation (V-A ECMO) and Impella device implantation, prior to further management decisions.⁶ Impella devices are frequently used in CS in patients with severe AS. However, utilizing an Impella with TAVI is difficult due to complex device-device interactions that create additional hemodynamic and technical challenges.⁷ To our knowledge, there are no reports of using an Impella 5.5 in a recently placed TAVI in patients with refractory CS as a bridge to additional

therapy. Here, we present a case in which a patient with refractory CS, after a recently placed TAVI, underwent successful left ventricular assist device (LVAD) destination therapy using an Impella 5.5 as a bridge to durable LVAD implantation.

Case Report

Patient History and Presentation

The patient is a 68-year-old male with a history of bicuspid aortic valve status post-surgical bioprosthetic aortic valve replacement (#21 Trifecta, Abbott), coronary artery disease status post coronary artery bypass graft (saphenous venous graft to posterior descending artery and left internal mammary artery to left anterior descending artery), hypertension, and tobacco use disorder. He initially presented to an outside hospital with dyspnea and was found to be in progressive Society for Cardiovascular Angiography and Interventions (SCAI) stage D cardiogenic shock. Vasopressor and inotropic support were initiated. He was found to have severe biodegradation of his bioprosthetic valve on a transthoracic echocardiogram (TTE) and was transferred to our institution for emergent valve-in-valve (ViV) TAVI and consideration for advanced therapies.

On arrival, he was tachycardic to 102 beats per minute and still required vasopressor support for adequate perfusion. Physical exam was notable for an elevated jugular venous pressure to 14 cm of water and cool lower extremities with 1+ peripheral edema. A right heart catheterization (RHC) prior to arrival revealed a right atrial pressure (RAP) of 20 mm Hg, pulmonary arterial (PA) pressure of 70/30 (43) mm Hg, pulmonary capillary wedge pressure of 40 mm Hg, PA oxygen saturation of 56%, and a cardiac index (CI) of 1.48 L/min/m². He had a lactate of 3.2 mmol/L, an N-terminal pro b-type natriuretic peptide level of 24,933 ng/L, and transaminitis. Troponins were within normal limits.

Diagnosis and Intervention

His initial TTE (Figures 1 and 2) showed a left ventricular ejection fraction (LVEF) of 5-10%, global hypokinesis of the left ventricle, grade 2 diastolic dysfunction, severely reduced right ventricular (RV) function, severe mitral regurgitation (MR), and severe AS of the prosthesis (gradients peak = 61 mm Hg, mean blood pressure = 40 mm Hg, area = 0.2 cm²/m², dimensionless valve index (DVI) = 0.1, left ventricular outflow tract stroke volume index = 11 mL/m²). The left ventricular internal end-diastolic diameter (LVIDD) was 6.9 cm. He was then taken to the cardiac catheterization lab for an emergent ViV TAVI.

A #20 Edwards Sapien 3 valve (Edwards Lifesciences) was successfully placed via a transfemoral approach (Figure 3), and no paravalvular leak was seen on the post-operative aortogram. Despite a technically successful procedure, he was still in a low output state, requiring escalating inotropic and vasopressor support in the days following. This continued despite mild improvement on post-TAVI echocardiography, which showed an LVEF of 10-15% and slightly improved AS (peak gradient = 28 mm Hg; prosthetic valve mean gradient = 14 mm Hg, DVI = 0.2) (Figure 4). LVIDD remained at 6.9 cm. Although his LVEF and peak gradients mildly improved, he remained in persistent SCAI Stage D shock despite a well-seated valve. This was evidenced by worsening RHC numbers (CI = 1.2 L/min/m²) and escalating milrinone and epinephrine requirements. It was believed that his worsening hemodynamics were due to his underlying ischemic cardiomyopathy, which may have been out of proportion to his valvular disease. Our team opted not to perform a diagnostic left heart catheterization at the time of the TAVI, given his negative troponins, so this etiology was not entirely excluded.



Figure 1. Parasternal long axis pre-transcatheter aortic valve implantation (ejection fraction 5-10%)

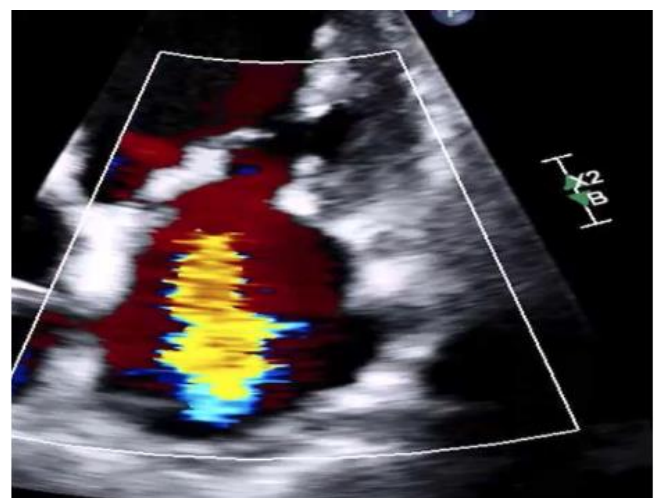


Figure 2. Apical four chamber view with color showing severe mitral regurgitation before the transcatheter aortic valve implantation

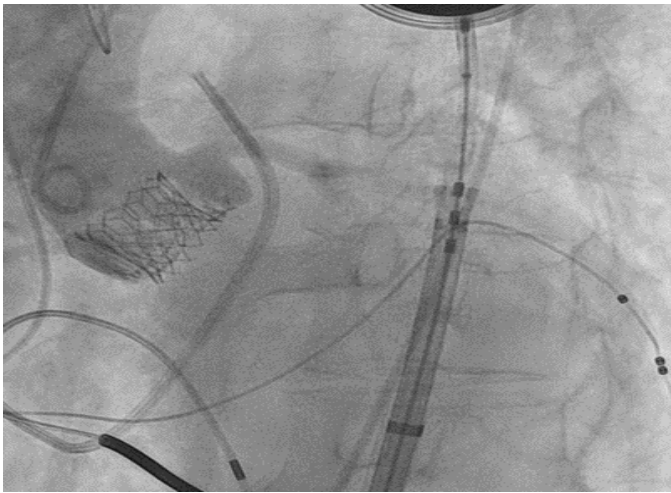


Figure 3. Successful valve in valve implantation of #20 Edwards Sapien 3 Valve (Edwards LifeSciences)

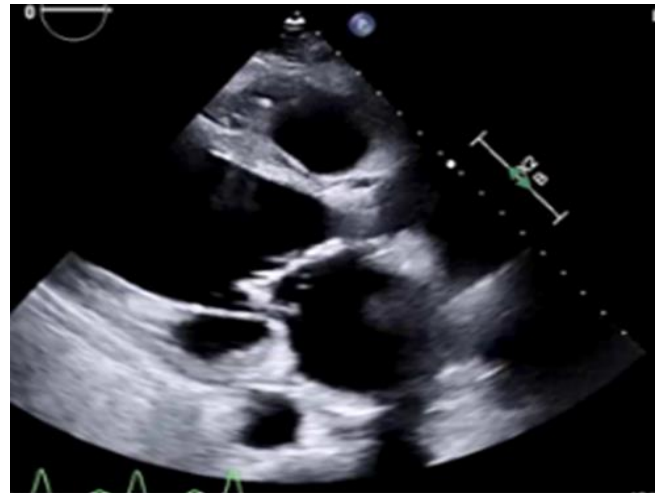


Figure 4. Parasternal long-axis view of post-transcatheter aortic valve implantation (ejection fraction = 15-20%)

Given his worsening shock, the multidisciplinary team reconvened to discuss further management strategies. He was briefly trialed on an intra-aortic balloon pump without significant hemodynamic improvement, and his SCAI Stage D shock continued to worsen. After discussion, an Impella 5.5 was placed via an axillary cutdown (Figure 5) seven days post-TAVI with the goal of bridging to recovery versus a durable LVAD as the destination therapy. (He was not a candidate for an orthotopic heart transplant.) There was a brief discussion about using the TandemHeart (CardiacAssist, Inc.) or left atrial veno-arterial cannulation (LAVA) ECMO as a bridging strategy. However, the team ultimately decided to use the Impella 5.5 as the bridging strategy on account of the institutional familiarity and comfort with the device insertion.

Post Impella 5.5, his course was complicated by a gastrointestinal bleed requiring multiple transfusions, which ultimately resolved with conservative management. With the implantation of the Impella 5.5, his hemodynamics improved, and he was weaned off vasoactive and inotropic medications.



Figure 5. Parasternal long axis showing the proper positioning of the Impella 5.5 (Abiomed)

Outcome

Given his clinical improvement after Impella 5.5 implantation, he was successfully extubated, and a full evaluation for advanced therapies was performed. He was deemed a candidate for LVAD therapy. Ten days after Impella 5.5 placement, he was taken back to the operating room for Impella 5.5 explantation and Heartmate 3 LVAD (Abbott) implantation as destination therapy. The LVAD was placed via a left thoracotomy without complication. He also underwent a concomitant percutaneous, temporary right ventricular assist device (RVAD) placement for persistent RV dysfunction. The RVAD was removed a week later. He continued to undergo guideline-directed medical therapy optimization, and a TTE two weeks after LVAD implantation showed an LVEF of 30%, normal RV function, trace MR, and a well-seated TAVI valve with a peak gradient of 3 mm Hg and a mean gradient 2 mm Hg. He continued to progress and was discharged to acute rehabilitation. He is now home and attends follow-up appointments in the heart failure clinic. He is participating in a cardiac rehabilitation program, and his dyspnea has resolved.

Comment

While the use of an Impella device is a common therapy for refractory CS, severe AS is a relative contraindication to its use as MCS.⁶ There are few case reports in which an Impella has been used for support in patients with aortic valve disease, but to our knowledge, an Impella 5.5 has never been used as therapy. Additionally, we have not seen any cases in which an Impella device has been implanted across a recently placed TAVI with a #20 Sapiens Valve as a bridge to destination therapy. Further adding to the complexity of this case was that the TAVI was done inside a surgically placed bioprosthetic aortic valve.

Although the evidence is clear that the best therapy for CS secondary to AS is valve replacement, there is a paucity of evidence on the best course of action to support patients in refractory CS after a technically successful TAVI. Our case

demonstrates the feasibility of placing an Impella 5.5 device across a recently placed TAVI and its utility as a bridge to LVAD destination therapy. However, it should be noted that in July of 2023, the Food and Drug Administration (FDA) issued a Class 1 Device recall of the Impella 5.5 with a TAVI because of the potential interaction between the blades of the Impella and the distal stent of the TAVI, resulting in low flow from Impella damage as well as systemic embolization of fractured Impella material.⁸ Given this new information, our heart team would have likely opted for LAVA-ECMO or a TandemHeart as a bridging approach to the LVAD destination therapy. It is possible that using a #20 Edwards Sapien Valve may have been protective against complications. Another valve, such as the CoreValve (CoreValve), may have led to complications with the Impella 5.5 due to the longer frame of the self-expanding valve.⁹ The use of Impella 5.5 and CoreValve would likely have increased complications; however, given the patient's worsening hemodynamics, the risk of further clinical deterioration was high if MCS was not started. As mentioned above, it may have been practical to move forward with a LAVA-ECMO strategy versus TandemHeart as our bridging strategy; however, the FDA announced this recall after this case was performed.

This case also demonstrated the importance of a multidisciplinary heart team approach to managing complicated patients. The decision to move forward with an Impella 5.5 device was made after carefully considering the patient's comorbidities, available destination therapies, and other factors. Without a multidisciplinary approach among a group of experts, this patient may not have undergone these interventions and been able to return home.

Ethical Statement

Consent was obtained from the patient for publication.

Disclosures:

Joyce Wald, DO: Speaker for Impulse Dynamics, Advisory Board for Boston Scientific and Abiomed; Marisa Cevasco, MD: Consultant for Abiomed; Jay Giri, MD: Research funds and Advisory Board for Boston Scientific, Abott Vascular,

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References

- [1] VanDyck TJ, Pinsky MR. Hemodynamic monitoring in cardiogenic shock. *Curr Opin Crit Care*. 2021;27(4):454-459. doi:10.1097/MCC.0000000000000838
- [2] Bernard S, Deferm S, Bertrand PB. Acute valvular emergencies. *Eur Heart J Acute Cardiovasc Care*. 2022;11(8):653-665. doi:10.1093/ehjacc/zuac086
- [3] Kvaslerud AB, Santic K, Hussain AI, et al. Outcomes in asymptomatic, severe aortic stenosis. *PLoS One*. 2021;16(4):e0249610
- [4] Singh V, Macon CJ, Scot Shaw E, Londoño JC, Martinez CA. Transcatheter aortic valve replacement: techniques, complications, and bailout strategies. *Postgrad Med*. 2013;125(5):31-42. doi:10.3810/pgm.2013.09.2697
- [5] Tomii D, Okuno T, Heg D, et al. Validation of the VARC-3 technical success definition in patients undergoing TAVR. *JACC Cardiovasc Interv*. 2022;15(4):353-364. doi:10.1016/j.jcin.2021.11.013
- [6] Singh V, Mendirichaga R, Inglessis-Azuaje I, Palacios IF, O'Neill WW. The role of Impella for hemodynamic support in patients with aortic stenosis. *Curr Treat Options Cardiovasc Med*. 2018;20(6):44. doi:10.1007/s11936-018-0644-9
- [7] Konami Y, Sakamoto T, Suzuyama H, Unoki T. Successful emergent transcatheter aortic valve implantation and left ventricular unloading by Impella in a patient with severe aortic stenosis who experienced cardiogenic shock after primary percutaneous coronary intervention for ST-elevation myocardial infarction: A case report. *Eur Heart J Case Rep*. 2021;5(2):ytab033. doi:10.1093/ehjcr/ytab033
- [8] US Food and Drug Administration (FDA). Class 1 Device Recall Impella 5.5 with SmartAssist. Accessed August 2, 2023. <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfres/res.cfm?id=200242>.
- [9] Noorani A, Bapat V. Differences in outcomes and indications between Sapien and CoreValve transcatheter aortic valve implantation prostheses. *Interv Cardiol*. 2014;9(2):121-125. doi:10.15420/icr.2011.9.2.121