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CORONARY, PERIPHERAL, AND STRUCTURAL INTERVENTIONS

CLINICAL CASE

Percutaneous Management of Left Ventricular Perforation Causing Late Cardiac Tamponade After Transcatheter Aortic Valve Implantation

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ABSTRACT

BACKGROUND We present a case of left ventricular perforation and delayed cardiac tamponade after transcatheter aortic valve implantation (TAVI) managed percutaneously. This report describes a novel technique for management of left ventricular perforation after TAVI.

CASE SUMMARY We performed elective transfemoral TAVI in a frail 85-year-old lady. Anatomical challenges included tortuous and horizontal aorta and a small left ventricular cavity. A 23-mm Sapien valve was implanted. She developed cardiac tamponade the next day needing emergency pericardiocentesis. Left ventricular angiogram showed perforation of the lateral wall. SURGIFLO Hemostatic Matrix was injected into the pericardial space using Agilis steerable introducer with a good outcome.

DISCUSSION Cardiac perforation and tamponade are serious and potentially fatal complications after TAVI. The outcomes in these patients remain poor with high mortality rate even with emergent cardiac surgery. This report describes a novel technique for management of left ventricular perforation after TAVI. (JACC Case Rep. 2025;30:103193) Crown Copyright © 2025 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/).

Transcatheter aortic valve implantation (TAVI) is an established therapy for symptomatic severe aortic stenosis.[1,2] Left ventricular (LV) perforation is a rare but serious complication that may occur during TAVI and is associated with a very high mortality rate.[3] This risk is increased in those with challenging aortic and LV anatomy. Here we present an unusual case of delayed presentation of LV perforation that was successfully managed without the need for open surgical repair using Surgiflo

TAKE-HOME MESSAGES

- Importance of recognizing high-risk anatomical features during TAVI planning like small and hyperdynamic left ventricle, left ventricular outflow tract calcium, and tortuous and horizontal aorta.
- Possible causes for cardiovascular collapse after TAVI need to be identified and managed promptly.

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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.

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ABBREVIATIONS AND ACRONYMS

TAVI = transcatheter aortic valve implantation

LV = left ventricular

hemostatic matrix. Surgiflo is a hemostatic matrix comprising gelatin and thrombin used to control bleeding during cardiac surgery.[4]

HISTORY OF PRESENTATION

The patient is an 85-year-old lady who has been under surveillance in the cardiology clinic for moderate aortic stenosis. She presented acutely with worsening breathlessness and leg swelling for 3-4 months. There were no symptoms of angina, palpitations, or syncope. Clinical examination revealed bilateral pitting pedal edema and a harsh ejection systolic murmur on auscultation in the aortic area. A clinical diagnosis of symptomatic severe aortic stenosis precipitating heart failure was made. The patient was started on diuretics with improvement in symptoms.

Past medical history included inferior ST-segment elevation myocardial infarction a decade ago, treated with primary percutaneous intervention to right coronary artery. There was moderate residual left anterior descending artery disease managed with medical therapy. She also had hypertension, severe kypho-scoliosis, and limited mobility due to a combination of frailty and kypho-scoliosis.

INVESTIGATIONS

Echocardiography showed progression in the peak and mean aortic valve gradient up to 86 and 49 mm Hg (previously 60 and 31 mm Hg) and aortic valve area 1.0 cm^2 (indexed aortic valve area: 0.6 cm^2/m^2). She had concentric remodelling of left ventricle and hyperdynamic ventricle with a small cavity (interventricular septum: 1.0 cm; posterior wall: 1.0 cm; LV end-diastole diameter: 3.9 cm; LV end-systole diameter: 2.1 cm; LV mass: 71 g/m^2; LV relative wall thickness: 0.51; LV end diastolic volume: 67 mL; LV end systolic volume: 14.7 mL; LV ejection fraction: 78%). Computed tomography TAVI demonstrated heavily calcified (Agatston score: 2,537), tri-leaflet aortic valve with intrusive nodular annular calcification extending into left ventricular outflow tract (**Figure 1**). Significant tortuosity was noted in the abdominal and descending thoracic aorta secondary to kypho-scoliosis. Ascending aorta was horizontal (**Figure 2**). Her Society of Thoracic Surgeons' score of operative mortality in urgent isolated surgical aortic valve replacement was 5.9% (intermediate risk). Considered together with her frailty and severe kyphosis the Heart Team consensus recommended TAVI in preference to surgical aortic valve replacement.

VISUAL SUMMARY Timeline of the Case

Date	Events
Day 0	Transfemoral TAVR using 23 S3 balloon expandable valve in a 85 year old frail lady
Day 1	Cardiac tamponade, urgent pericardiocentesis
Day 1	Taken back to the cath lab, LV angiogram showed LV perforation. SurgiFlo hemostatic matric inserted in pericardial cavity using agilis sheath.
Day 1	Shifted back to ICU, hemodynamically stable, pericardiac drain kept in situ.
Day 3	Pericardial drain removed, no reaccumulation of effusion on echocardiogram
Day 4	Discharged
Week 6	Follow-iup in clinic, TAVR functioning well on echocardiogram, no pericardial effusion.

MANAGEMENT AND PROCEDURAL DETAILS

After the Heart Team discussion, she was offered transfemoral TAVI under local anesthesia and sedation. The plan was to implant a 23-mm Edwards Sapien 3 Ultra valve (Edwards Lifesciences) with 1 mL less than nominal volume in view of adverse annular calcification.

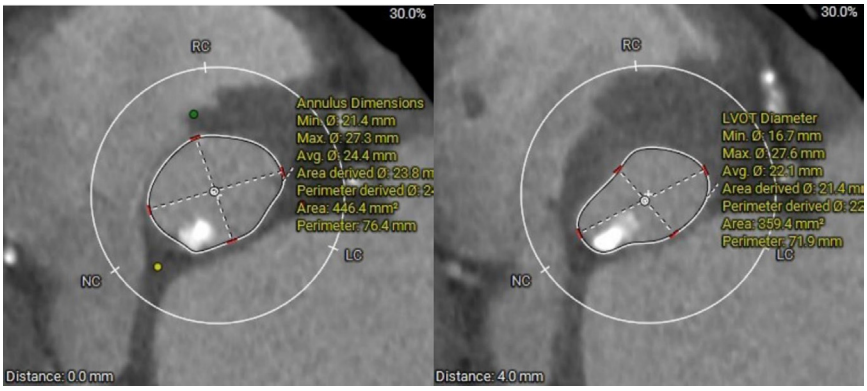
Initial attempts to place a Safari extra small curve wire (Boston Scientific) through the pigtail catheter proved unsuccessful as the catheter would prolapse out of the LV as the curved Safari wire passed through the tortuous aorta. The valve was recrossed and a double curved Lunderquist stiff wire (Cook Medical) was placed in the LV through a 6-F EBU 3.0 guiding catheter (Medtronic). The position of the Lunderquist wire curve was suboptimal but was accepted due to the difficulties encountered in crossing this valve (**Figure 3**). The TAVI valve system successfully passed through the tortuous and calcified aorta over the supportive Lunderquist wire.

After predilation, a 23-mm Edwards Sapien 3 Ultra valve was deployed under rapid pacing with no immediate complications. There was trace aortic regurgitation on transthoracic echocardiogram immediate post-deployment with no pericardial effusion. There was no change to conduction on electrocardiogram. Good hemostasis was achieved. The patient was transferred to the coronary care unit for overnight monitoring.

POSTPROCEDURAL COURSE AND MANAGEMENT OF COMPLICATION

She remained well overnight but became abruptly hypotensive next morning (around 18 h after procedure). A bedside echocardiogram showed a pericardial effusion causing cardiac tamponade (Video 1, **Figure 4**). She was taken back to the catheter laboratory for urgent pericardiocentesis. Pericardiocentesis was performed under local anesthesia from the subcostal window under fluoroscopic and ultrasound guidance. Her hemodynamics improved after pericardiocentesis. A left ventriculogram demonstrated

FIGURE 1 **CT TAVI: Annular and LVOT Calcium**



CT = computed tomography; LVOT = left ventricular outflow tract; TAVI = transcatheter aortic valve implantation.

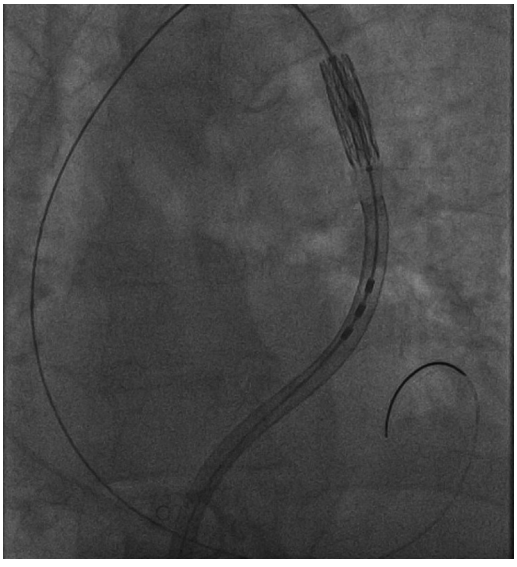
perforation of lateral LV wall with ongoing bleeding into the pericardium (Video 2). An emergency Heart Team meeting was convened in the catheter laboratory. Emergency surgery was considered but deemed to be high risk. The decision was taken to attempt percutaneous management by instilling Surgiflo Hemostatic Matrix to control the bleeding.

The pericardial drain was swapped for a steerable 8.5-F Agilis sheath (Abbott Laboratories). The Agilis sheath was steered and manipulated to position over lateral LV wall and confirmed on fluoroscopy (**Figure 5**). A total of 27 mL flowable hemostatic matrix (SURGIFLO Hemostatic Matrix) was instilled directly through the Agilis sheath. Repeat echocardiogram showed no reaccumulation of pericardial effusion.

FIGURE 2 **CT Reconstruction: Horizontal Tortuous Aorta With Calcification**

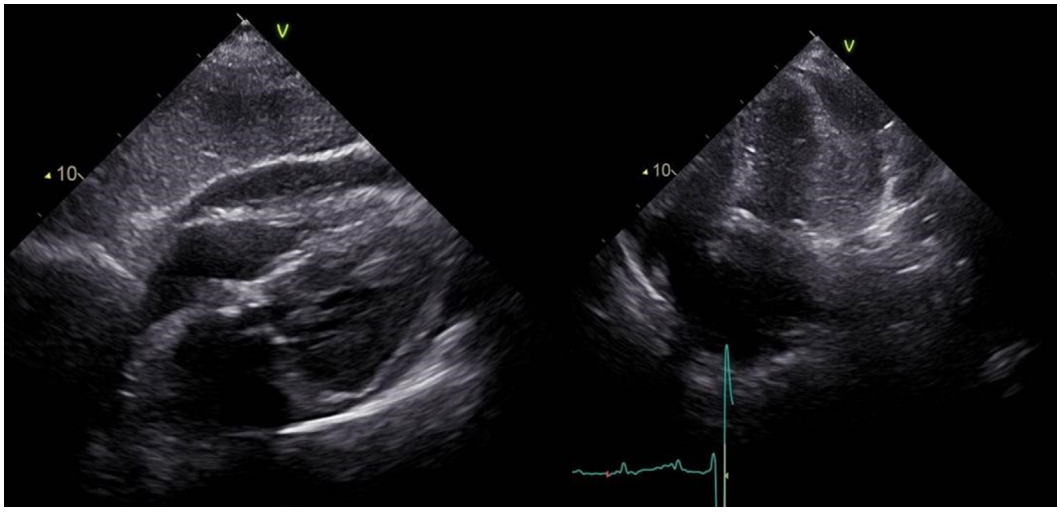
Abbreviations as in **Figure 1**.

FIGURE 3 **Position of Stiff Wire in LV**



LV = left ventricle.

FIGURE 4 Transthoracic Echocardiogram: Pericardial Effusion With Tamponade



We considered repeating the left ventriculogram, but we did not want to raise the LV pressure with a pressure injector and risk bleeding recurrence. The pericardial drain was kept in situ for 48 h. After confirming no significant residual pericardial effusion, the drain was removed. She recovered well and was discharged home a week from her initial admission.

FOLLOW-UP

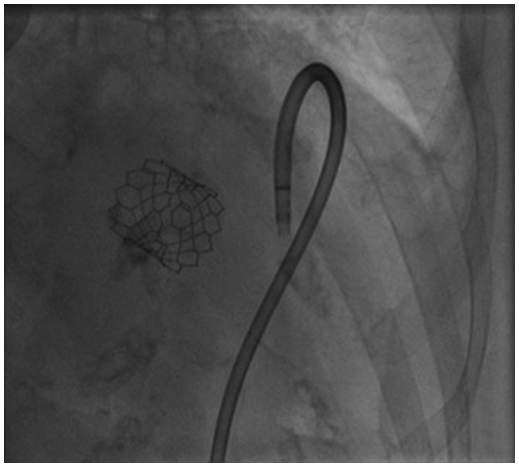
She was reviewed in clinic 6 weeks after discharge. She was well and had NYHA functional class 1 symptoms and was leading an active life. Her echocardiogram showed a well-seated TAVI valve with mild paravalvular aortic regurgitation. Her LV function was normal with no pericardial effusion.

DISCUSSION

Cardiac perforation and tamponade are serious and potentially fatal complications after TAVI. Registry data have shown that cardiac perforation and tamponade, although relatively uncommon during TAVI, have a very high morbidity.[3,5] The outcomes in these patients remain poor with high mortality rate even with emergent cardiac surgery.[3,6] Cardiac tamponade during TAVI can be caused by the temporary pacing wire in the right ventricle, the wire in the left ventricle, or due to annular injury during valve deployment. It has been noted that outcomes are worse when the perforation is in the high pressure left ventricle.[6] In our case the positioning of the Lunderquist wire in the left ventricle was difficult due to aortic tortuosity. A suboptimal wire position was accepted, and the perforation was likely caused by the tip of the Lunderquist wire. Emergency surgery was thought to be high risk due to the patient's frailty and comorbidities. Thus, alternative percutaneous option was considered in the first instance. A percutaneous solution was pursued with consensus from the Heart Team and with the patient's consent. This was deemed a reasonable option due to the unusual, delayed presentation and a small defect noted on the LV angiogram.

Owais et al[7] have identified a small LV cavity size, hypercontractile left ventricle, thin muscular wall,

FIGURE 5 Fluoroscopic Position of Agilis Sheath: Injection of Surgical Glue in Pericardium



and narrow aorto-mitral angle as predictors of LV perforation during TAVI. Small LV size is known to predict worse outcomes after TAVI both at 30 days and 2 years of follow-up.[8,9] Our patient had a small hypercontractile left ventricle and a narrow aorto-mitral angle close to 90 degrees. The horizontal tortuous calcified aorta necessitated complex manipulation of the guidewires in the ventricle. Because of the anatomy, our guidewire position was also directed toward the LV lateral wall.

A percutaneous technique was used to treat cardiac perforation where surgical risk was considered prohibitive. This technique has been described by Jones et al,[10] in tamponade developing after annular rupture. Directed delivery of hemostatic matrix (SURGIFLO Hemostatic Matrix) using a steerable Agilis sheath was successful in sealing the perforation with a good outcome. Gelatin thrombin hemostatic matrix provides a framework for the patient's platelets to aggregate, thus facilitating the coagulation cascade. Piayda et al[11] have described the role of the ventricular muscle band with its circumferential and transverse fibers in sealing small, circular perforations. There remains the theoretical risk of developing pericardial constriction in the future. Close clinical and echocardiographic follow-up is planned.

CONCLUSIONS

The challenging anatomy and suboptimal position of the stiff wire in the left ventricle was the likely reason for LV perforation. Intrapericardial Surgiflo hemostatic matrix application sealed the perforation. Prompt interventional management led to a good outcome in a high-risk situation. The Heart Team discussion was helpful with colleagues from other disciplines suggesting using the Agilis sheath and assisting in preparing the Surgiflo for instillation.

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KEY WORDS Agilis steerable introducer, cardiac perforation, delayed cardiac tamponade, SURGIFLO Hemostatic Matrix

APPENDIX For supplemental videos, please see the online version of this paper.