JACC: CASE REPORTS VOL. 1, NO. 5, 2019

CASE REPORT

ADVANCED

CLINICAL CASE

Aorto-Right Ventricular Fistula and Paravalvular Leak After Transcatheter Aortic Valve Implantation

Ahmed M. Alabbady, MD,[a] Sudhakar Sattur, MD, MHSA,[b] Terry D. Bauch, MD,[c] Kishore J. Harjai, MD[c]

ABSTRACT

Aorto-right ventricular fistula is a potentially fatal complication following transcatheter aortic valve implantation (TAVI). This paper presents a case of successful percutaneous repair of aorto-right ventricular fistula and paravalvular leak after TAVI by using 3D-printed models for pre-procedural planning, and a review of published aorto-right ventricular fistula cases to date. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2019;1:859–64) © 2019 The Authors. 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/).

CASE

PRESENTATION. A 76-year-old male presented for evaluation of symptomatic severe aortic stenosis. Despite having a Society of Thoracic Surgeon score of 3%, he was recommended for transcatheter aortic valve replacement (TAVR) by 2 surgeons due to his comorbidities.

MEDICAL HISTORY. The patient had a medical history significant for chronic obstructive pulmonary disease, obstructive sleep apnea with reported noncompliance with continuous positive airway pressure therapy, severe arthritis, and polyneuropathy which severely limited his ambulation capacity and gait stability, and paroxysmal atrial fibrillation on chronic anticoagulation.

LEARNING OBJECTIVES

- To recognize and anticipate aorto-right ventricular (RV) fistula as an early complication of transcatheter aortic valve implantation;
- To realize the safety and feasibility of percutaneous closure of aorto-RV fistula;
- To recognize the role of the 3-dimensional models in planning complex structural heart interventions.

INVESTIGATIONS. Transthoracic echocardiography showed an aortic valve mean gradient of 51 mm Hg, a peak velocity of 4.2 m/s, and an aortic valve area of 0.6 cm^2. Pre-procedural computed tomography (CT) (**Figure 1**) was performed, and an aortic annulus of 32- × 26-mm with an area of 660 mm^2 was measured.

INITIAL INTERVENTION. The patient underwent transesophageal echocardiogram-guided TAVR using a Sapien 3 29-mm (Edwards Lifescience, Irvine, California) using a right femoral approach at an outside hospital. Immediately after deployment, there was evidence of a moderate paravalvular leak (PVL), and additional balloon inflations reduced the leak to mild. The procedure was complicated immediately by new first-degree atrio-ventricular block, and left bundle

From the [a]Cardiology Department, Geisinger Medical Center, Danville, Pennsylvania; [b]Cardiology Department, Guthrie Clinic, Sayre, Pennsylvania; and the [c]Cardiology Department Geisinger Wyoming Valley Medical Center, Wilkes-Barre, Pennsylvania. The authors have reported that they have no relationships relevant to the contents of this paper to disclose. Konstantinos Charitakis, MD, served as Guest Associate Editor for this paper.

Informed consent was obtained for this case.

Manuscript received September 25, 2019; revised manuscript received November 5, 2019, accepted November 5, 2019.

ISSN 2666-0849 https://doi.org/10.1016/j.jaccas.2019.11.025

JACC: CASE REPORTS, VOL. 1, NO. 5, 2019
DECEMBER 18, 2019:859–64

ABBREVIATIONS AND ACRONYMS

CT = computed topography

PPM = permanent pacemaker

PVL = paravalvular leak

Qp = pulmonary flow

Qs = systemic flow

TAVI = transcatheter aortic valve implantation

VSD = ventricular septal defect

branch block requiring temporary pacing. At 3 days after the procedure, the patient developed complete heart block and underwent permanent pacemaker placement. Transthoracic and transesophageal echocardiograms showed aorto-right ventricular fistula with a concern for supra-annular tear or rupture with a small PVL. He was hemodynamically stable and so was managed conservatively. Two weeks later, he was rehospitalized for syncope and was noted to be in clinical acute heart failure. His permanent pacemaker (PPM) was interrogated and showed unsustained ventricular tachycardia. A repeated transthoracic echocardiography did not show any significant change from prior tests, suggesting increased right ventricular pressure and volume overload as possible causes for his ventricular tachycardia. Electrophysiology staff were consulted and recommended that the patient be discharged on LifeVest (Zoll Medical, Chelmsford, Massachusetts) pending closure of his fistula and PVL. Right heart catheterization done at that admission showed a pulmonary flow/systemic flow (Qp/Qs) ratio of 1.43. A heart team discussion was held, and the decision was to pursue percutaneous approach.

The patient was subsequently transferred to the authors' hospital for further management of

FIGURE 1 Pre-Transcatheter Aortic Valve Replacement Computed Topography

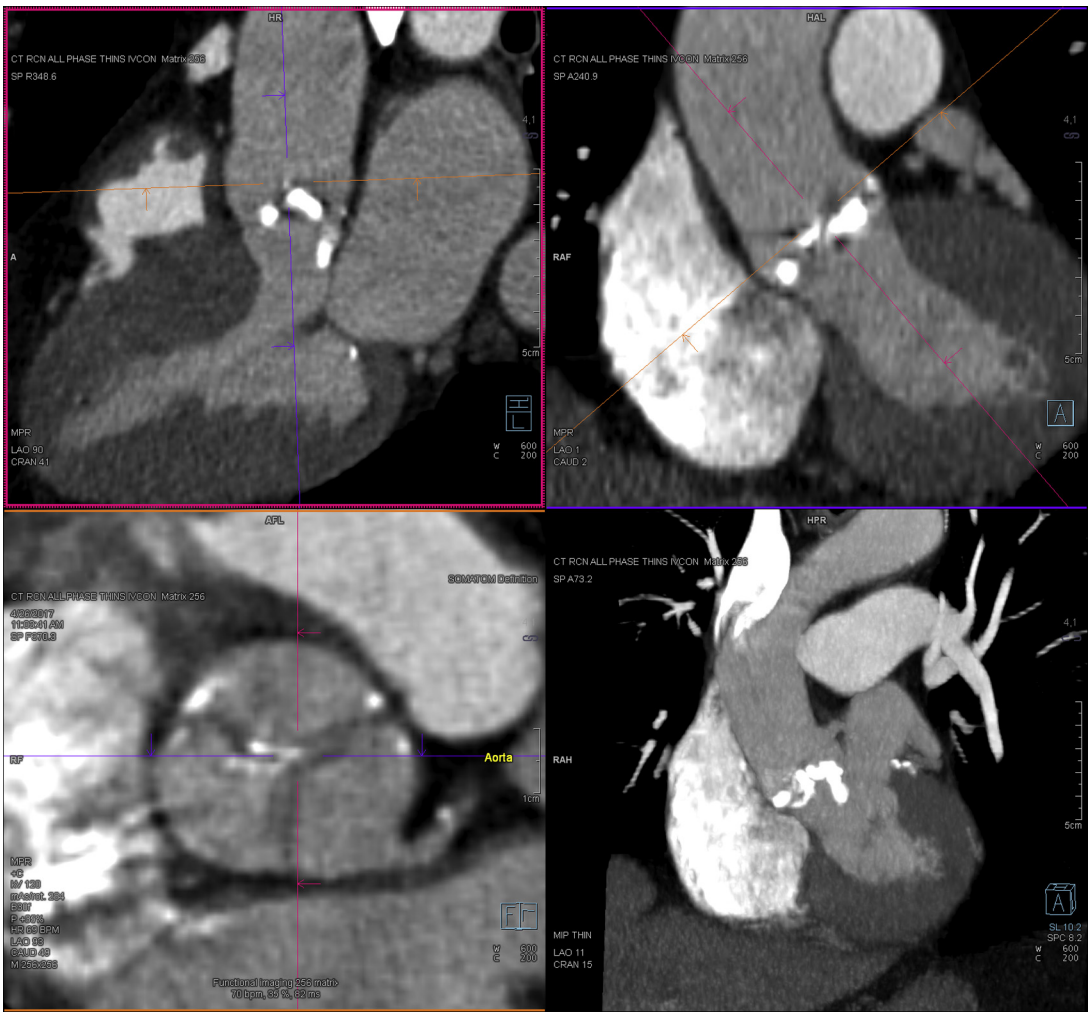
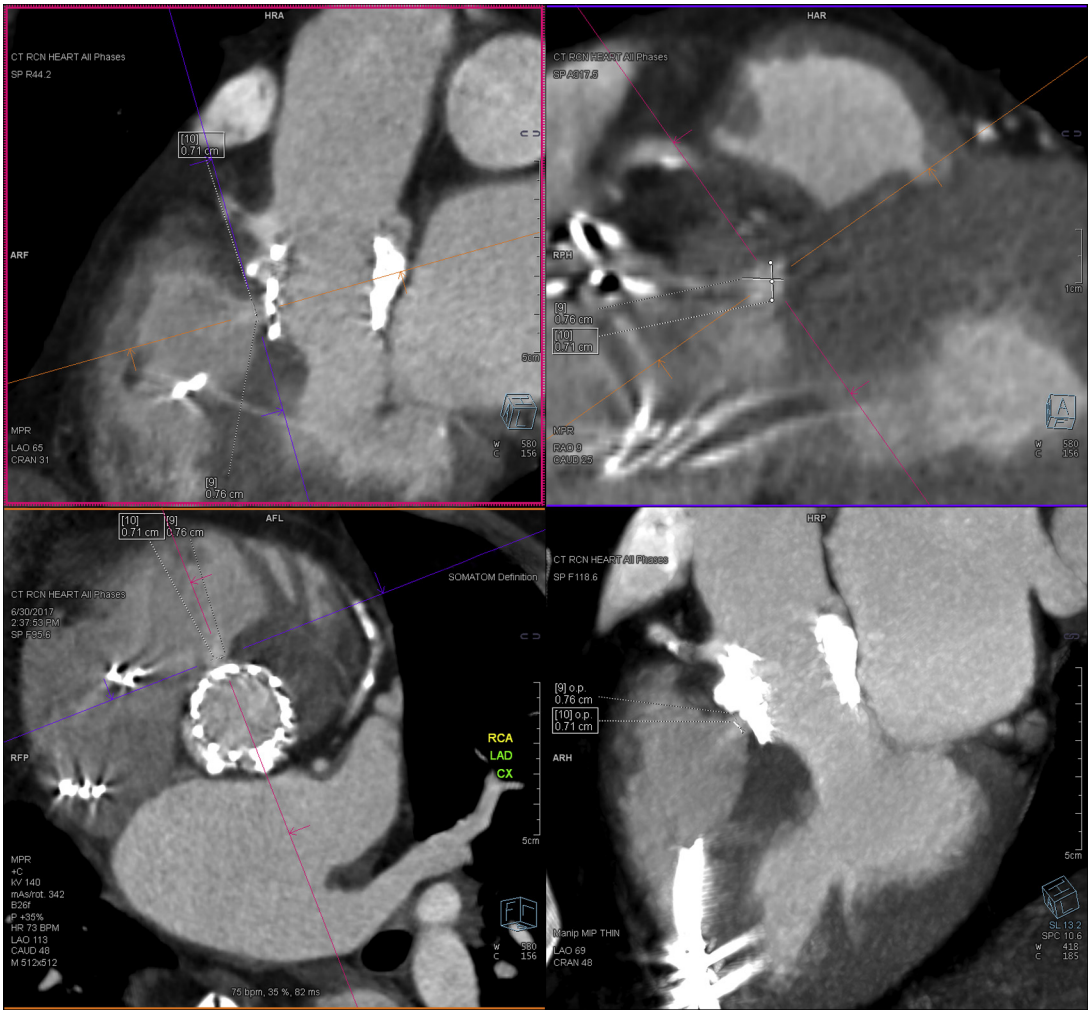


FIGURE 2 Computed Tomography Scan Images Showing the Anatomy of the Aorto-Right Ventricular Fistula



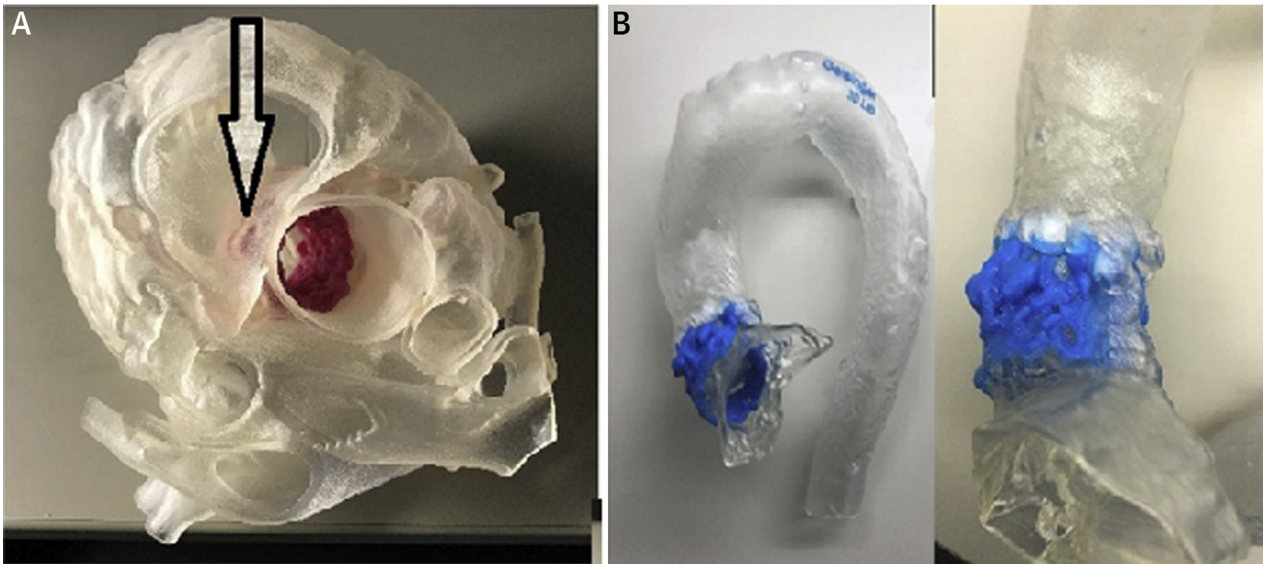
aorto-right ventricular fistula and PVL. The fistula was measured and evaluated by cardiac CT (**Figure 2**). CT data were processed with Mimics Innovation Suite software (Materialise, Leuven, Belgium) to create a 3-dimensional (3D) model incorporating the relevant anatomy and printed (**Figure 3**) using an Objet 360 printer (Statasys, Eden Prarie, Minnesota). This model was reviewed by the interventional team to aid in planning the procedure.

MANAGEMENT. Under transesophageal guidance (Video 1), the defect was crossed with a Wholey wire (Covidien, Mansfield, Massachusetts) (Video 2), over which a glide catheter was advanced, and then an Amplatzer Super Stiff wire (Boston Scientific, Marlborough, Massachusetts) was advanced. The glide catheter and 6-F left femoral artery sheath were removed and a 7-F shuttle sheath was advanced from left femoral artery to right ventricle. An 8-mm ventricular septal defect (VSD) closure device was then advanced across the fistula (Video 3). The RV sheath was deployed, and the left side disc was unsheathed. The device was examined fluoroscopically in multiple views. Despite the left side disc expansion being limited by the transcatheter aortic valve implantation (TAVI) prosthesis, multiple push and pull maneuvers confirmed device stability, and it was successfully deployed (**Figure 4**).

Post-deployment transesophageal echocardiogram (Video 4) shunt study showed reduction in right ventricle saturations from 88% to 63% in setting of right ventricle saturations of 60%, suggesting nearly complete abolition of left-to-right shunt. The patient was discharged home on therapy that included

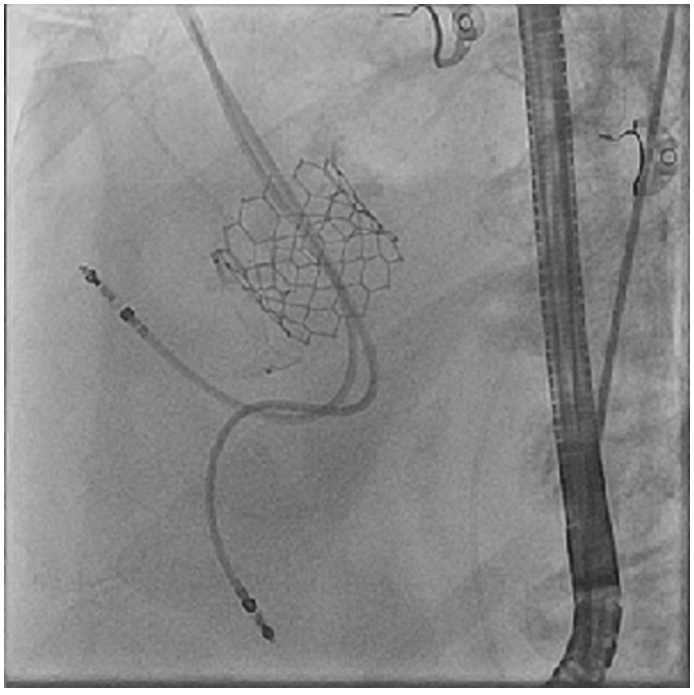
JACC: CASE REPORTS, VOL. 1, NO. 5, 2019
DECEMBER 18, 2019:859–64

FIGURE 3 3-Dimensional Model of the Patient's Aortic Valve and Ascending Aorta Showing the Prosthetic Valve and the Aorto-Right Ventricular Fistula Location



aspirin, 81 mg, warfarin, dose managed by anticoagulation pharmacy, metoprolol tartrate, 50 mg twice daily, and daily torsemide, 20 mg daily. Four months after the procedure, the patient was brought back to close his paravalvular leak that had progressed in severity, requiring 2 Amplatzer vascular plugs, 8-mm devices deployed successfully (**Figure 5**) under transesophageal echocardiogram guidance (Videos 5, 6, 7, 8, and 9). Electrophysiology reevaluated the patient at that time. He had no shocks from his LifeVest. His PPM interrogation showed no recurrence of his ventricular tachycardia, and recommendations were against upgrading his PPM to an automatic implantable cardioverter defibrillator. Use of his LifeVest was discontinued, and he was discharged home on unchanged medical regimen.

FIGURE 4 Fluoroscopic Image of Successful Implantation of Ventricular Septal Defect Occluder Device



At 23 months follow-up, the patient continued to do well with NYHA functional class II symptoms on a chronic regimen of aspirin, 81 mg daily, warfarin, dose managed by anticoagulation clinic, metoprolol tartrate, 50 mg twice daily, and diuretic therapy with daily 20 mg of torsemide. Follow- up transthoracic echocardiograms showed normally functioning prosthesis, no further PVL, and a well-seated VSD device with a small leak around the device, but no significant shunting was noted. His routine device interrogation showed no further recurrence of his ventricular tachycardia.

DISCUSSION

Despite the fact that aorto-RV fistula is a rare complication, the increasing number of TAVR procedures used across the United States will result in encountering rare complications more frequently. There are no guidelines available to assist with

management of those patients. Aorto-RV fistula closure using a percutaneous device represents a technical challenge because the TAVI valve is expected to interfere with secure placement of larger closure devices like VSD occludes.

This paper reports the case of successful closure of aorto-RV fistula and PVL after TAVI using a VSD occluder device and 2 Amplatzer vascular plugs. A comprehensive search of published studies revealed only 12 cases of aorto-RV fistula following TAVR with high mortality rate (**Table 1**) (1–12). All 4 patients who underwent percutaneous repair survived, and 3 of the other 8 cases managed conservatively died. Society of Thoracic Surgeon scores, root measurements, or aortic calcifications were not reported in those cases. All patients were treated using balloon expandable valves. All had significant left-to-right shunts which were evident by high Qp/Qs ratios with the onset of congestive heart failure symptoms in 2 to 4 weeks after the index procedure.

CONCLUSIONS

Aorto-RV fistula is a rare but serious and potentially fatal complication following TAVR. Percutaneous

FIGURE 5 Final Fluoroscopic Image After Successful Implantation of Ventricular Septal Defect and 2 Amplatzer Vascular Plugs

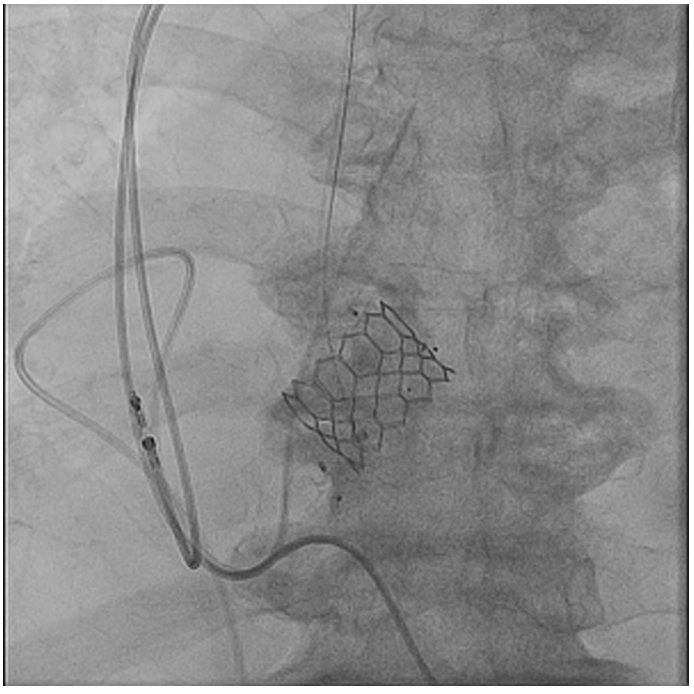


TABLE 1 Comparison of All Published Cases of Aorto-RV Fistula

First Author (Ref. #)	Age, yrs/Sex	Valve Size	PVL Onset After TAVI	Reported Symptoms	Qp/Qs Ratio	Management	Outcome
Shakoor et al. (1)	89/M	SAPIEN 29-mm	30 days	Dyspnea on exertion	1.39	Observation	Died
Pilgrim et al. (2)	91/F	SAPIEN 26-mm	1 month	Dyspnea on exertion	1.4	Coil embolization	Survived
Leroux et al. (3)	47/M	SAPIEN XT 26-mm	3 weeks	N/A	N/A	Observation	Died
Leu et al. (4)	78/F	SAPIEN 26-mm	2 weeks	N/A	1.13	Observation	Survived
Muñoz-García et al. (5)	85/M	CoreValve 29-mm	72 h	Asymptomatic	1.53	Observation	Survived
Nakamura et al. (6)	54/M	SAPIEN XT 29-mm	5 days	BiV failure	1.7	ASD occluder	Survived
Hagiwara et al. (7)	83/M	SAPIEN XT 29-mm	Immediate	N/A	1	Observation	Survived
Hamandi et al. (8)	93/M	SAPIEN XT 29-mm	1 day	N/A		VSD occluder	Survived
Almanfi et al. (9)	92/M	SAPIENT XT 29-mm	1 day	Asymptomatic	none	Observation	Survived
Vainrib et al. (10)	91/M	CoreValve 29-mm	4 months	CHF symptoms	N/A	AVP vascular plug	Survived
Verma et al. (11)	80/M	CoreValve 29-mm, followed by second CoreValve 29-mm for severe intravalvular leak	Immediate	Asymptomatic	1	Observation	Survived
Konda et al. (12)	88/F	SAPIEN XT 26-mm	2 weeks	None initially, then developed CHF after 3 months	2:1	Refused	Died
Alabbady et al.	76/M	Sapien 3 29-mm	2 weeks	Progressive since procedure, CHF 2 weeks	1.43	VSD occluder	Survived

ASD = atrial septal defect; BiV = bi-ventricular; CHF = congestive heart failure; N/A = not available; PVL = paravalvular leak; Qp/Qs = pulmonary flow/systemic flow ratio; RV = right ventricle; TAVI = transcatheter aortic valve implantation; VSD = ventricular septal defect.

repair is feasible and safe and should be strongly considered in symptomatic patients with significant Qp/Qs ratios. More data are needed to evaluate outcomes and determine the optimal strategies for repair.

ADDRESS FOR CORRESPONDENCE: Dr. Kishore Harjai, Cardiology Department, Geisinger Wyoming Valley Medical Center, 1000 East Mountain Blvd, Wilkes-Barre, Pennsylvania 18711. E-mail: kharjai419@gmail.com.

REFERENCES

1. Shakoor MT, Islam AM, Ayub S. Acquired aorto-right ventricular fistula following transcatheter aortic valve replacement. Case Rep Cardiol 2015; 2015:1–3.

2. Pilgrim T, Meier B, Wenaweser P. Aorto-right ventricular fistula after transfemoral aortic valve implantation. J Invasive Cardiol 2010;22:E30–1.

3. Leroux L, Dijos M, Peltan J, et al. Lethal aorto-right ventricular defect after transcatheter aortic valve implantation in a patient with radiation-induced porcelain aorta: notes of caution. Can J Cardiol 2016;32:135. e9–135.

4. Leu HB, Chang HH, Wu MH, et al. Four-year follow-up of acquired aorto-right ventricular fistula after transcatheter aortic valve implantation. Eur Heart J 2016;37:2679.

5. Muñoz-García AJ, Rodríguez-Bailón I, Briales JH, et al. Aorto-right ventricular fistula after percutaneous aortic valve implantation of a CoreValve prosthesis. Tex Heart Inst J 2011;38: 728–9.

6. Nakamura K, Passeri JJ, Inglessis-Azuaje I. Percutaneous closure of acute aortoright ventricular fistula following transcatheter bicuspid aortic valve replacement. Catheter Cardiovasc Interv 2017;90:164–8.

7. Hagiwara K, Saito N, Yamazaki K, Kimura T. Aorto-right ventricular fistula following transcatheter aortic valve implantation using a 29 mm SAPIEN XT valve. BMJ Case Rep 2017;bcr-2017-219247.

8. Hamandi M, Potluri S. Aorto-right ventricular fistula closure after TAVR guided by intracardiac echocardiography. Structural Heart 2019;3:252–4.

9. Almanfi A, Qurie A, Strickman N. Aorto-right ventricular shunt after TAVR: rare complication of common procedure. Case Rep Cardiol 2017;1834394.

10. Vainrib AF, Ibrahim H, Hisamoto K, et al. Aorto-right ventricular fistula post-transcatheter aortic valve replacement: multimodality imaging of successful percutaneous closure. Case 2017;1:70–4.

11. Verma S, Kakar P, Moskovits N, Shani J, Frankel R. Aorta to RV fistula: a rare complication of TAVR. Available at: https://www.cathlabdigest.com/article/Aorta-RV-Fistula-Rare-Complication-TAVR. Accessed November 27, 2019.

12. Konda MK, Kalavakunta JK, Pratt JW, Martin D, Gupta V. Aorto-right ventricular fistula following percutaneous transcatheter aortic valve replacement: case report and literature review. Heart Views 2017;18:133.

KEY WORDS aortic valve, complication, valve replacement

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