Cardiol Ther (2021) 10:599–607
https://doi.org/10.1007/s40119-021-00227-5

CASE REPORT

Imaging-Guided Transcatheter Aortic Valve Replacement and Percutaneous Coronary Intervention in Decompensated Severe Aortic Stenosis with Acute Renal Impairment

Karim Elbasha · Rayyan Hemetsberger · Gert Richardt · Abdelhakim Allali

Received: May 6, 2021 / Accepted: June 10, 2021 / Published online: June 28, 2021

ABSTRACT

An 82-year-old woman with severe aortic valve stenosis (AS) and a significant proximal right coronary artery (RCA) stenosis presented with decompensated heart failure and acute kidney injury. She was treated with intravascular ultrasound (IVUS)-guided percutaneous coronary intervention (PCI) and trans-oesophageal echocardiography (TOE)-guided transcatheter aortic valve replacement (TAVR).

Keywords: Aortic valve stenosis; Transcatheter aortic valve replacement; Pneumonia; Acute kidney injury

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40119-021-00227-5.

K. Elbasha (✉) · R. Hemetsberger · G. Richardt · A. Allali
Heart Centre, Segeberger Kliniken GmbH, Bad Segeberg, Germany
e-mail: karim.elbasha@segebergerkliniken.de

Key Summary Points

Decompensated heart failure in case of severe AS is challenging and requires urgent treatment particularly when complicated with renal impairment.

Understanding the pathophysiology is a cornerstone for proper management. Our patient developed acute cardiorenal syndrome with a vicious circle of worsening renal function then improper diuresis to worsening heart failure, so we had to interrupt this circle by treating the precipitating factor which was severe AS.

Despite absence of evidence, TAVR still plays an important role in complicated cases of severe AS with acute heart failure.

IVUS-guided PCI is a known approach that helps to overcome the problem of contrast medium in patients with renal impairment.

We can rely on TOE and fluoroscopy during TAVR, but this requires good understanding of the anatomy of the aortic root.

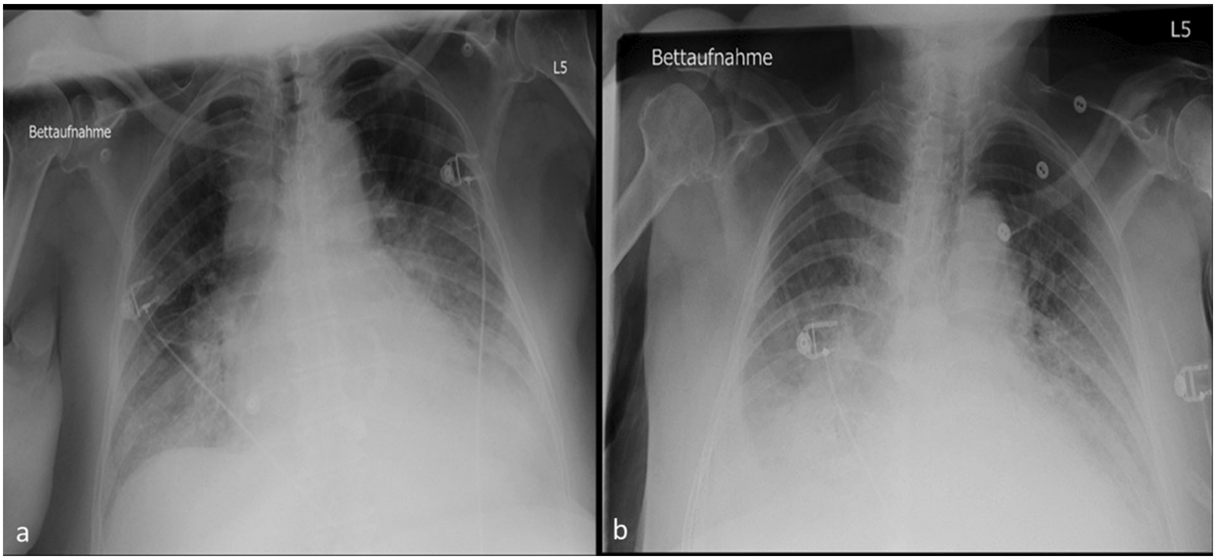

Fig. 1 Chest X-ray. **a** On admission showing left basal consolidation and mild pleural effusion, **b** after 3 days with prominent congestion and increasing bilateral pleural effusion

DIGITAL FEATURES

This article is published with digital features, including videos to facilitate understanding of the article. To view digital features for this article go to https://doi.org/10.6084/m9.figshare.14754516.

CASE

History of Present Illness

An 82-year-old women, with a history of arterial hypertension and severe aortic valve stenosis (AS), was planned for transcatheter aortic valve replacement (TAVR) but postponed because of contrast-induced acute kidney injury (AKI) after coronary angiography and computed tomography (CT) [(creatinine 5.3 mg/dL (0.47 mmol/L)]). She presented before the planned appointment with progressive dyspnoea for 3 days before admission.

On admission, the patient was alert with cough, expectoration and dyspnoea NYHA III, blood pressure 130/100 mmHg, heart rate 81 bpm, temperature 36.7 °C.

The patient had been admitted to the intensive care unit and received heart failure and antibiotic treatment. Her clinical condition deteriorated with progressive dyspnoea, worsening kidney function with anuria and pulmonary oedema and finally required haemodialysis.

Investigations

Laboratory

Total leucocyte count 13.1 × 10^3/μL, CRP 12.88 mg/dL (122.7 nmol/L), pro-BNP 7073 pg/mL (836.3 pmol/L), creatinine 1.37 mg/dL (0.12 mmol/L) progressed to 3.55 mg/dL (0.31 mmol/L), blood culture was negative.

Chest X-ray

On admission chest X-ray showed consolidation in the basal left lung and mild pleural effusion (Fig. 1a). X-ray 3 days later showed increasing lung congestion with bilateral pleural effusion (Fig. 1b), so pleurocentesis was performed; 1450 mL pleural fluid was drained and proved to be transudate after analysis.

Echocardiography

Left ventricular ejection fraction 65%, no wall motion abnormalities, aortic valve was heavily calcified with mean pressure gradient of

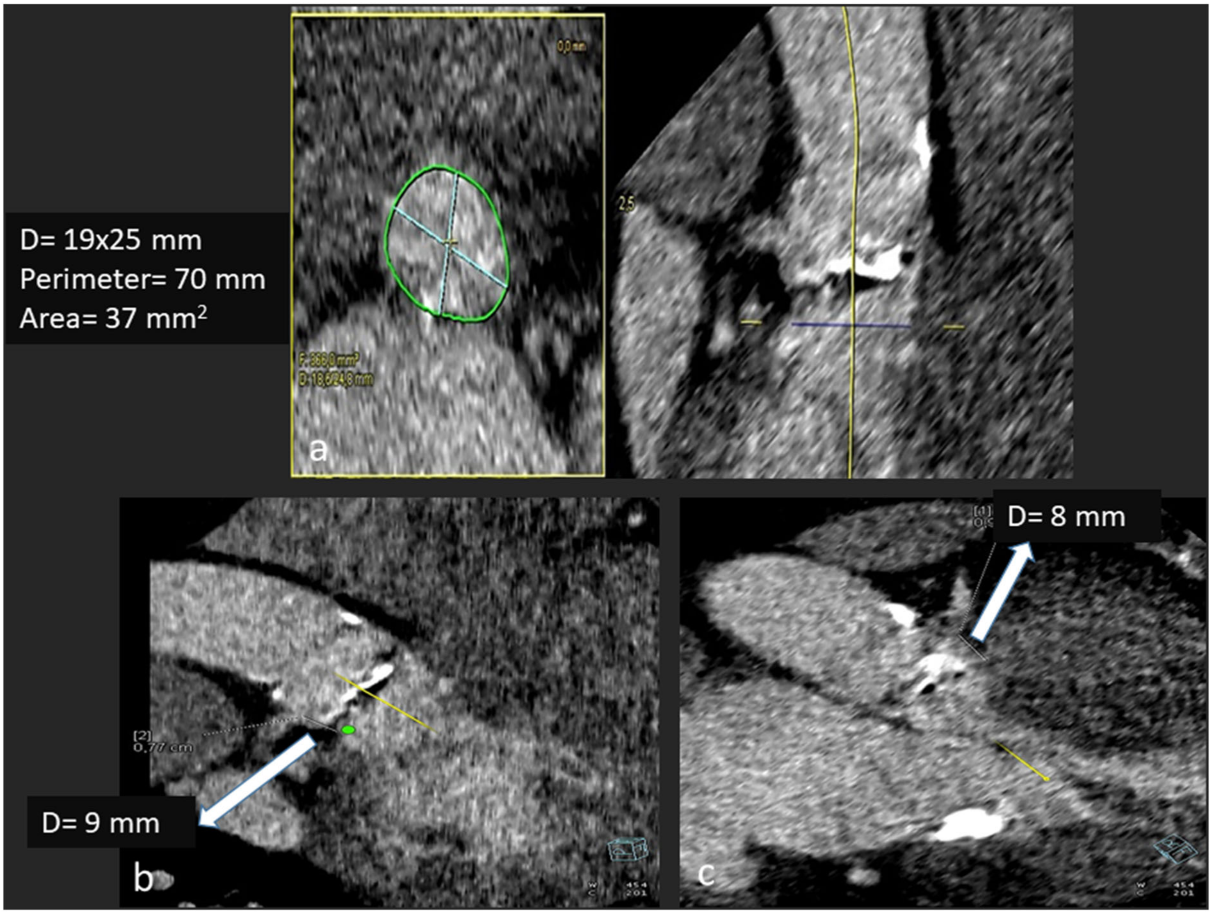

Fig. 2 CT aortography before TAVR. **a** Aortic annulus perimeter. **b** & **c** distance of RCA and LM from the annulus (poor image quality because the patient could not hold her breath)

65 mmHg and aortic valve area (AVA) was 0.43 cm^2, stroke volume index (SVi) was 33 mL/beat/m^2. Trans-oesophageal echocardiography (TOE) showed AVA of 0.9 cm^2 with mild aortic insufficiency and degenerative mild mitral regurgitation.

CT Aortography

CT aortography (in a previous admission) showed aortic annulus diameter of 19 × 25 mm, perimeter was 70 mm and area 37 mm^2 (Fig. 2a), distance of coronary ostia from the annulus (right coronary artery (RCA) 9 mm, left main coronary artery (LM) 8 mm) (Fig. 2b, c). Calcium score was 3936 Agatston units (AU), right external iliac artery minimal diameter was 7 mm and the left was 8 mm while right common femoral minimal diameter was 4 mm and the left was 8 mm.

Coronary Angiography

Coronary angiography (in a previous admission) showed a significant stenosis in the RCA with angiographically normal left coronary artery (LCA) (Figs. 3 and 4).

Management

Under antibiotics, infection parameters decreased and blood culture was negative; nevertheless the patient was in pulmonary oedema and anuria. In this high-risk patient (STS score 10.03% and EuroSCORE II 15.38%) with drug-resistant cardiorenal syndrome, the heart team

Fig. 3 Coronary angiogram of the RCA showing angiographically significant proximal RCA stenosis

Fig. 4 Coronary angiogram for the left coronary artery (LCA) showing angiographically normal LCA

decided to perform intravascular ultrasound (IVUS)-guided percutaneous coronary intervention (PCI) on the RCA then TOE-guided TAVR to avoid contrast. The decision to perform PCI for RCA was only dependent on the angiographic assessment (about 80%) and we could not perform non-invasive tests because the patient was decompensated; additionally the physiological assessment (FFR or iFR) is still doubtful in the presence of severe AS [1]. For fear of LM occlusion after TAVR—low ostium position—the decision was to advance a stent into the left anterior descending coronary artery (LAD), in parking position, without inflation.

A written informed consent was obtained from the patient for using and publishing her data with all measurements and rights of data protection according to the local ethics committee approved guidelines (Helsinki Declaration of 1964, as revised in 2013).

Procedure

The procedure was performed under elective intubation and deep sedation. The left common femoral artery was punctured under fluoroscopic guidance and selected to be the access for TAVR (depending on the measurements from the CT) while the right femoral access was chosen as a secondary access and for RCA PCI. A Judkin right (JR) 4.0 6F guiding catheter engaged the RCA. Without use of contrast media, a guide wire was advanced into the RCA (Video 1), followed by an IVUS pullback. During continuous pullback the distal and the proximal landing zones for the stent were documented by fluoroscopy as well as IVUS showed that the minimal lumen area (MLA) was 3.4 mm^2, minimal diameter was 1.7 mm and the area stenosis was 79%. After the size and length of the lesion were obtained (Fig. 5a), a drug-eluting stent (3.0 × 28 mm; DES) was implanted under fluoroscopic orientation followed by post dilation using a 3.5 × 15 mm non-complaint balloon. The result was controlled fluoroscopically with clear-stent and with IVUS (Fig. 5b). The stent was well expanded without evidence of edge dissections. A Judkin left (JL) 4.0 6F guiding catheter was used to engage the LM and 4.0 × 15 mm DES was advanced into LAD without inflation; then the guiding catheter was disengaged into the aorta, leaving the guide wire with the DES parked in the LAD. A pigtail catheter was advanced to the non-coronary

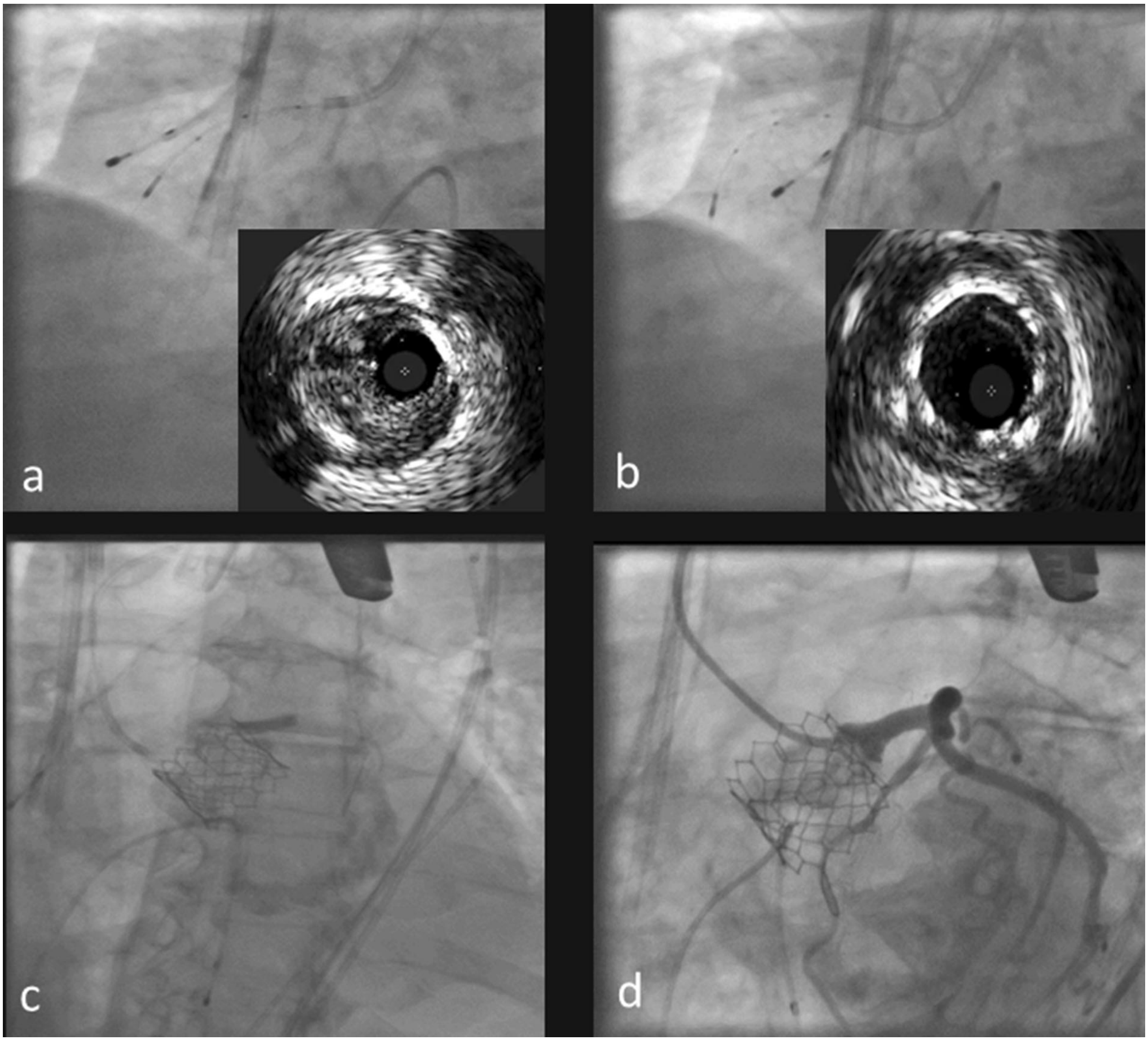

Fig. 5 PCI procedure. **a** IVUS for RCA to measure the lesion size and length, **b** IVUS after stent inflation to assess stent expansion and complication, **c** LM stent inflation after jailing, **d** angiography after LM stenting with 5 mL contrast

cusp to guide the annulus level. With TOE and fluoroscopic guidance, a 26-mm balloon expandable Edwards Sapien 3 Ultra (Edwards Lifescience, Irvine, CA, USA) trans-catheter valve was implanted (Figs. 6 and 7 and Video 2). After TAVR, peak-to-peak gradient was 2 mmHg, aortic regurgitation index was 28, and TOE showed good TAVR position with no insufficiency. The LAD stent shaft was jailed between aortic wall and valve with resistance during extraction attempt (Video 3). For fear of stent-loss, a bailout implantation in the LM was necessary (Fig. 5c) confirming the results with 5 mL contrast (Fig. 5d). The patient was extubated in the catheter laboratory and transferred to the intensive care unit.

Video 1: Fluoroscopy-guided RCA engagement. Engagement with JR4 and passage of the guide wire without contrast injection into distal RCA (MP4 3085 KB)

Video 2: TAVR implantation. Edwards Sapien 3 Ultra valve deployment and disengaged JL from left main trunk with the stent in parking position in middle LAD (MP4 11695 KB)

Video 3: Difficult withdrawal of the stent. Jailing of the stent shaft between TAVR device and

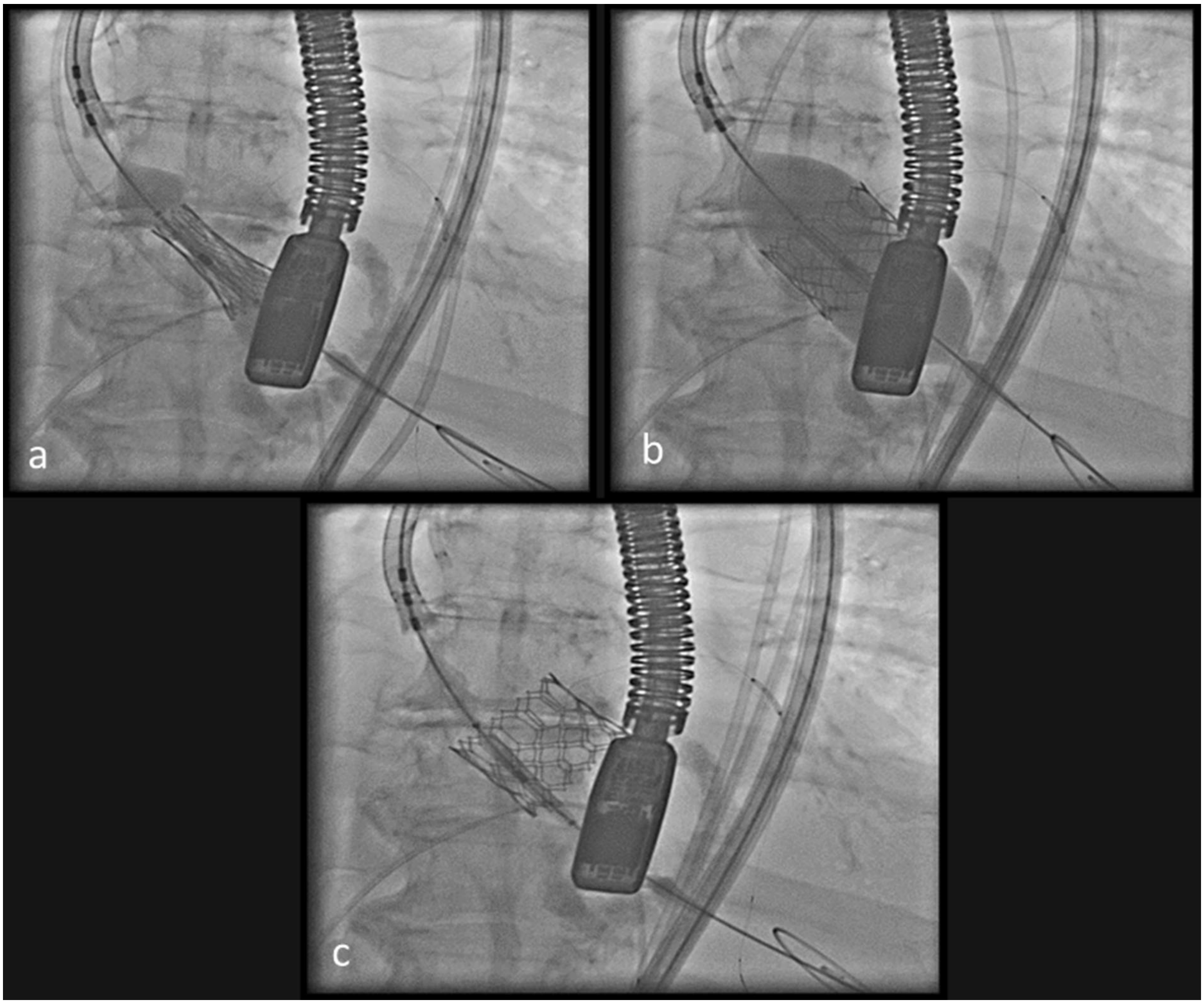

Fig. 6 TAVR procedure **a** showing pig tail catheter in non-coronary cusp and disengagement of the JL catheter in the aorta, **b** during valve balloon inflation, **c** after balloon deflation

aortic wall during withdrawal of the stent from LAD (MP4 613 KB)

Follow-Up Post-TAVR

On the second post-TAVR day, haemodialysis could be stopped. Creatinine improved to 1.91 mg/dL (0.17 mmol/L). Echocardiography revealed a well-seated prosthesis in the aortic position with a mean gradient of 17 mmHg and no para-valvular regurgitation; AVA was 1.33 cm^2. The patient was discharged 1 week after TAVR in a stable condition.

DISCUSSION

Our case sheds light on two important points: (1) the role of TAVR in acute heart failure, (2) the growing role of imaging-guided TAVR (fluoroscopy-TOE guidance) and PCI (IVUS guidance) particularly in case of renal impairment.

AS is the third most frequent cardiac disease after coronary artery disease and arterial hypertension, and is associated with a high incidence of adverse outcomes [2]. Moreover, it is frequently associated with abnormalities of the arterial system like cerebral, renal and coronary arteries [3].

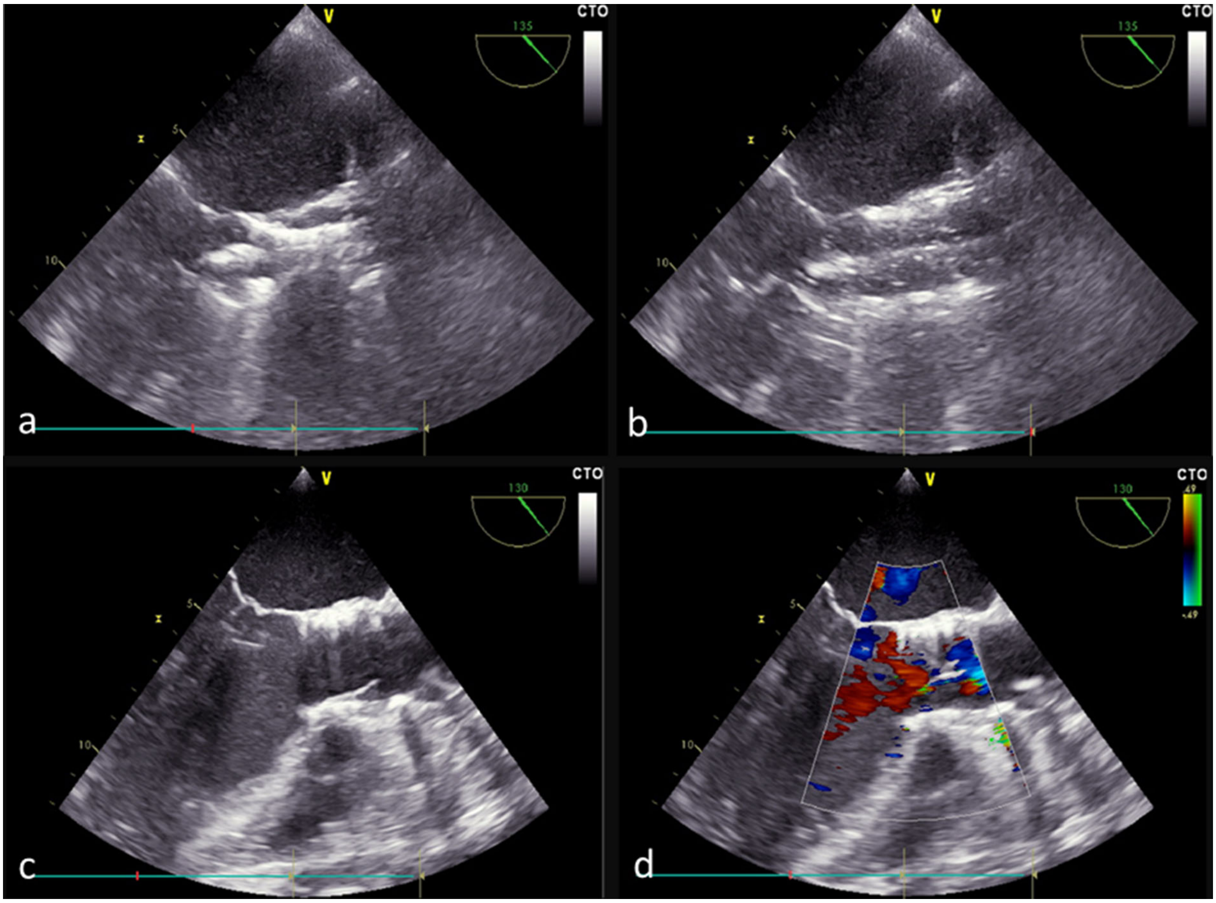

Fig. 7 TOE during TAVR procedure. **a** Adjustment of the valve position in three-chamber view, **b** during valve inflation, **c** after valve implantation showing good leaflet excursion, **d** colour flow Doppler (CFD) showing no significant aortic insufficiency

The prognosis of patients with severe AS complicated by decompensated heart failure is poor, with high rates of mortality. In addition, management of heart failure complicating severe AS is particularly challenging because patients easily develop severe congestion or acute decline in cardiac output [4]. We assume this is the pathophysiology that occured in our patient, renal hypoperfusion and subsequently renal impairment with anuria and increasing congestion. The patient entered in a vicious circle that we had to interrupt.

Several studies have confirmed that AKI is a strong predictor for short- and long-term mortality after TAVR [5]. However, in our case, AKI improved after TAVR and this could be explained by the normalization of cardiac output and body fluid redistribution after TAVR.

When one performs a TAVR without contrast, the main technical challenges relate to how to optimally position the valve prior to deployment. There are many described techniques e.g. angiographic, 3D TOE, and 2D TOE guided. In our case, fluoroscopy and TOE-guided TAVR was performed with the help of pigtail catheter in the non-coronary cusp to guide the exact annulus position. Bagur et al. showed that TOE-guided TAVR was associated with similar midterm results as angiography-guided TAVR and significant reduction of contrast media [6].

For intravascular imaging, we used IVUS as it is the imaging modality of choice in patients with advanced kidney disease because it does not require blood clearance by contrast injection as compared to optical coherence tomography.

CONCLUSION

Severe AS complicated by acute cardiorenal syndrome is a challenging situation. Fluoroscopy and TOE-guided TAVR in association with an IVUS-guided PCI may be a feasible solution for those patients.

ACKNOWLEDGEMENTS

Compliance with Ethics Guidelines. A written informed consent was obtained from the patient for using and publishing her data with all measurements and rights of data protection according to the local ethics committee approved guidelines (Helsinki Declaration of 1964, as revised in 2013).

Authorship. All named authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship for this article, take responsibility for the integrity of the work as a whole, and have given their approval for this version to be published.

Authors' Contributions. Karim Elbasha: data collection, writing and considering the concept and design. Gert Richardt: concept and drafting. Rayyan Hemetsberger: reviewing and drafting the data. Abdelhakim Allali: concept and design as well as drafting the case.

Disclosures. Dr. Abdelhakim Allali and Dr. Rayyan Hemetsberger received speakers' honoraria from Boston Scientific. Professor Gert Richardt received institutional research grants from St. Jude Medical, Biotronik and Medtronic. Karim Elbasha has nothing to disclose.

Funding. No funding or sponsorship was received for the study or publication of this article.

Data Availability. Data sharing is not applicable to this article (a case report) as no datasets were generated or analysed during the current study and all data are included in this published article/as supplementary information files.

REFERENCES

1. Pesarini G, Scarsini R, Zivelonghi C, et al. Functional assessment of coronary artery disease in patients undergoing transcatheter aortic valve implantation influence of pressure overload on the evaluation of lesions severity. Circ Cardiovasc Interv. 2016;9:e004088.

2. Rapp AH, Hillis LD, Lange RA, Cigarroa JE. Prevalence of coronary artery disease in patients with aortic stenosis with and without angina pectoris. Am J Cardiol. 2001;87(1216):7 (A7).

3. Pibarot P, Dumesnil JG. New concepts in valvular hemodynamics: implications for diagnosis and treatment of aortic stenosis. Can J Cardiol. 2007;23(Suppl B):40B-47B.

4. Nagao K, Taniguchi T, Morimoto T, et al. Acute heart failure in patients with severe aortic stenosis—insights from the CURRENT AS Registry. Circ J. 2018;82:874–85.

5. Elhmidi Y, Bleiziffer S, Piazza N, et al. Incidence and predictors of acute kidney injury in patients undergoing transcatheter aortic valve implantation. Am Heart J. 2011;161:735–9.

6. Bagur R, Rodes-Cabau J, Doyle D, et al. Usefulness of TEE as the primary imaging technique to guide transcatheter transapical aortic valve implantation. JACC Cardiovasc Imaging. 2011;4:115–24.