

Repeated transcatheter aortic valve implantation for the treatment of a degenerated transcatheter aortic valve implantation valve (valve-in-valve technique): a case report

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Background

Valve-in-valve transcatheter aortic valve implantation (TAVI) has emerged as a competent alternative for the treatment of degenerated bioprosthetic valves after surgical aortic valve replacement, or during TAVI procedure as a bailout option. Herein, we report a rare case of a self-expandable Medtronic Evolut R valve into a failing Medtronic CoreValve, with the use of modern pre-TAVI imaging screening, suggesting the proper procedural design steps for so complicated implantations.

Case summary

A frail 78-year-old woman with a degenerated Medtronic Core Valve 26 mm bioprosthesis, implanted in 2011 due to severe aortic stenosis, was referred to our hospital due to worsening dyspnoea New York Heart Association III. The screening echocardiography documented severe aortic stenosis, while the classical risk scores were in favour of repeated TAVI (EuroSCORE II 5.67%). Computed tomography measurements and three-dimensional (3D) printing model were of great help for the proper valve selection (Medtronic Evolut R 26 mm), while the use of cerebral protection device (Claret Sentinel) was considered as a necessary part of the procedure. The simultaneous use of fluoroscopy and transoesophageal echocardiogram led to optimal haemodynamic result, confirmed by the discharge echocardiogram, with a significant clinical improvement during the first month follow-up.

Discussion

The main periprocedural concerns remain valve malpositioning, coronary artery obstruction, and high remaining transvalvular gradients. The multimodality pre-TAVI imaging screening may be helpful for precise procedural design. Despite the limited use of 3D models, it is necessary to adopt such tissue-mimicking phantoms to increase the possibility of optimal procedural result.

Keywords

Degenerated bioprosthetic valve • Valve-in-valve implantation • 3D printing modelling • Cerebral protection device • Case report

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Learning points

- The valve-in-valve implantation requires accurate anatomical measurements pre-operatively.
- The multimodality pre-transcatheter aortic valve implantation imaging screening with computed tomography, transoesophageal echocardiogram, and three-dimensional (3D) printing modelling may be of great help to choose the proper treatment option.
- The use of 3D models needs to be widely expanded in the field of Interventional Cardiology for the precise design of valvular heart diseases treatment.

Introduction

Valve-in-valve (ViV) transcatheter aortic valve implantation (TAVI) has emerged as an alternative strategy for the treatment of degenerated bioprosthetic valves after surgical aortic valve replacement (SAVR) or during TAVI procedures as a bailout option.^{1,2} While the TAVI experience has already exceeded a 10-year period and numerous ViV procedures have been reported, only little is known about the long-term durability of these prostheses.³⁻⁵ On the other hand, technical issues are yet to be resolved⁶; the careful use of three-dimensional (3D) printing assessment⁷ may contribute to the selection of the proper therapeutic option, while any possible presence of thrombus on the degenerated valve should be systematically ruled out.^{4,8}

Herein, we describe a rare TAVI-in-TAVI procedure with a self-expandable Medtronic Evolut R valve into a degenerated Medtronic CoreValve (Medtronic Medical Devices, Minneapolis, MN, USA) using 3D printing assistance and Claret Sentinel dual carotid filter for cerebral protection. Our aim is to highlight the importance of pre-TAVI imaging assessment in so complicated cases, like demanding ViV procedures.

Timeline

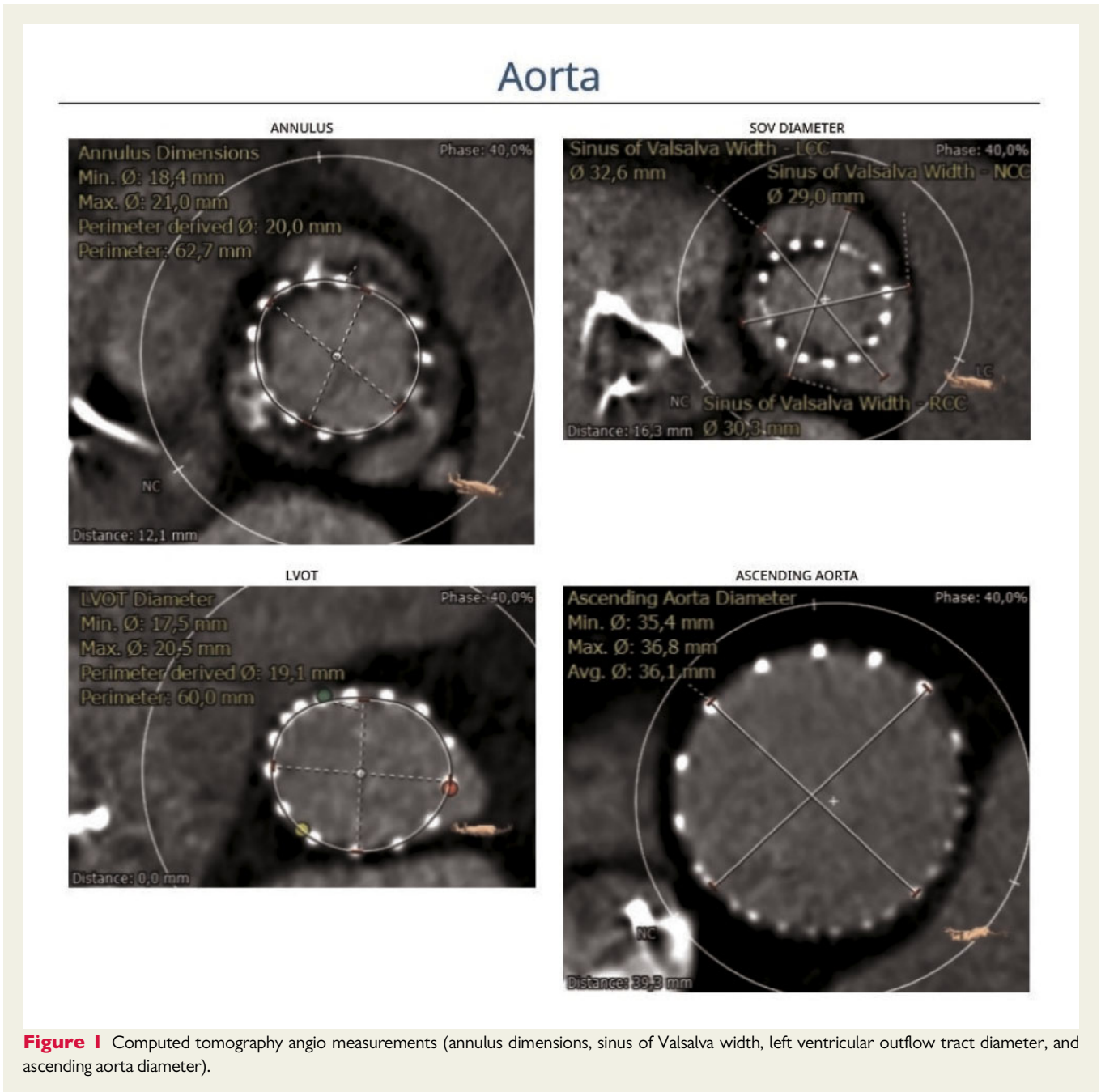
Eight years prior to presentation	Transcatheter aortic valve implantation (TAVI) due to severe aortic stenosis.
Three months prior to presentation	Dyspnoea on effort [New York Heart Association (NYHA) Class III] and easy fatigue. The screening echocardiography documented severe aortic stenosis. Multimodality imaging assessment with computed tomography and three-dimensional printed model.
Upon presentation to the Catheterization Laboratory	Successful TAVI in TAVI after post-dilatation with fluoroscopic and echocardiographic guidance.
After 6 days	Discharge from hospital.
After 30 days	The first month echocardiography confirmed the proper valve-in-valve function, with significant clinical improvement (NYHA I-II).

Case presentation

A frail 78-year-old woman with a malfunctioning Medtronic Core Valve 26 mm, implanted in 2011 via TAVI technique due to severe aortic stenosis, was admitted to our outpatient cardiology clinic due to worsening dyspnoea on effort [New York Heart Association (NYHA) Class III] and easy fatigue, despite the optimal medical treatment. The physical exam revealed a harsh crescendo-decrescendo systolic murmur at the right upper sternal border with radiation to the carotid arteries, blood pressure 119/71 mmHg, heart rate 70 b.p.m., oxygen saturation on room air 93%, respiratory rate 18/min, mildly elevated jugular vein pressure, bilateral basal crackles, and mild peripheral oedema. The screening echocardiography documented severe aortic stenosis with aortic valve area 0.75 cm², mean trans-aortic gradient 40 mmHg and max transaortic gradient 61 mmHg, preserved left ventricular function and right ventricular systolic pressure 60 mmHg, while the coronary angiography ruled out any significant coronary disease. Arterial hypertension, dyslipidaemia, pulmonary hypertension, and paroxysmal atrial fibrillation under anticoagulation were the main comorbidities, while a permanent pacemaker implantation was performed in 2011 post-TAVI due to complete heart block. Surgical risk scores were in favour of repeated TAVI (EuroSCORE II 5.67%),⁷ so the Heart Team of our hospital favoured percutaneous aortic ViV implantation over SAVR as the optimal strategy.

Based on computed tomography measurements (*Figure 1*),⁷ a 3D model was printed as a physical replica of patient's unique anatomy, offering the chance to have the final implantation of the selected 26 mm self-expandable Evolut R valve visualized pre-procedurally (*Figure 2*). The rationale comes from the need to understand simultaneously multiple elements of the complex aortic root anatomy (the shape and dimensions of the aortic annulus, sinuses of Valsalva and sinotubular junction; the relationship of the coronary artery ostia relative to these structures; the distribution of calcifications on the aortic leaflets, the left ventricular outflow tract, and the ascending aorta) while a new transcatheter valve has to be implanted into a degenerated one. The use of cerebral protection device was also considered as a necessary part of the procedure, to avoid the spread of calcified debris or thrombi, from both the native valve and the TAVI valve, to the systemic circulation.⁹

After informed consent was signed, the patient was transferred to the Catheterization Laboratory under general anaesthesia. While intravenous heparin infusion was used to achieve an activated clotting time of >200 s, a catheter Pigtail 6 F was placed to the aortic root for intervention guidance. At the same time, the Claret Sentinel device was placed from the anonymous artery to the left carotid artery via the right radial artery.⁹ Then, the



bioprosthesis was carefully advanced through the stiff Confida wire via the left femoral artery and was deployed progressively in line with the visible margin of the previously optimally implanted CoreValve (Figure 3). Haemodynamic and echocardiographic measurements ruled out any significant valvular regurgitation after the implantation, but underlined the need for post dilatation with Z-med balloon due to high remaining transvalvular gradient.⁴ When the optimal haemodynamic result was achieved (Figure 4), the whole delivery system was removed and the left femoral artery was sutured with two Proglide percutaneous closure systems, while the findings from the Sentinel device proved to be aortic calcified debris. The patient was successfully weaned from the mechanical ventilation in the Catheterization Laboratory

and was transferred to the Coronary Care Unit for further supervision. The echocardiography at discharge showed max aortic velocity 1.1 m/s and absence of significant paravalvular regurgitation, while the first month echocardiography confirmed the proper ViV function, with mean transvalvular gradient 2.6 mmHg across the valve (Figure 5).^{2,4} A significant clinical improvement (NYHA I-II) was also reported.

Discussion

The long-term durability of TAVI bioprosthetic valves remains a hot topic since its first introduction in 2002. Since the first published case

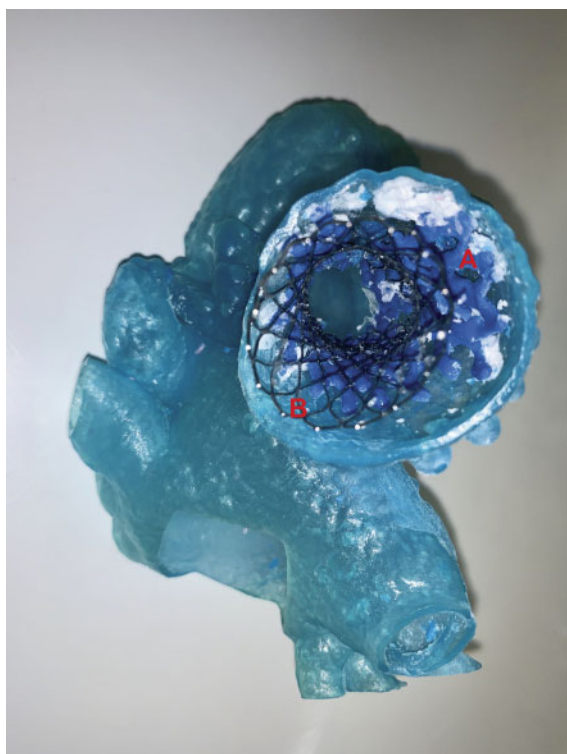


Figure 2 Three-dimensional printing modeling (A: degenerated CoreValve, B: Evolut R).

of TAVI-in-TAVI, a series of cases have been reported and several issues regarding proper terminology ('valve-in-valve', 'Russian doll concept', or 'TAVI-in-TAVI') appeared in the literature.⁵ On the other hand, the major periprocedural complications regarding this clinical scenario have been analysed such as bioprosthesis malpositioning, critical coronary flow obstruction⁶ and high post-operative transaortic gradients.^{4,5} Moreover, a possible valve underexpansion may affect the final leaflet configuration and function; consequently, the expected device durability may decline.⁵

The procedural success is greatly dependent on a multimodality pre-TAVI imaging assessment with computed tomography, transoesophageal echocardiogram, and 3D printing modelling,^{2,8,10} offering valuable tools for the optimal sizing of the transcatheter valve and the reduction of any significant paravalvular leak. Especially, the anatomical dimensions of the pre-existing bioprosthesis, derived from accurate computed tomography measurements, are of high importance for the appropriate TAVI valve selection and the procedural success.

Conclusions

Despite the limited experience with 3D models in TAVI, it is crucial to broaden the use of tissue-mimicking phantoms⁷ as an important educational tool for physicians and trainees involved in the case. A



Figure 3 Valve-in-valve procedure (A: TAVI-in-TAVI, B: Claret Sentinel Device).

visualized implantation model before the procedure may enhance communication with the patient and predict any procedural complications. Techniques such as material engineering, computer-assisted design and 3D printing technology are expected to meet the advances in diagnostic imaging, creating new solutions for both preprocedural assessment and treatment.^{8,10} It is obvious that the ViV evolution depicts a changing environment where the clinical needs not only to expand the limits of the modern technology but actively interact with the future.⁵

Lead author biography



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Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

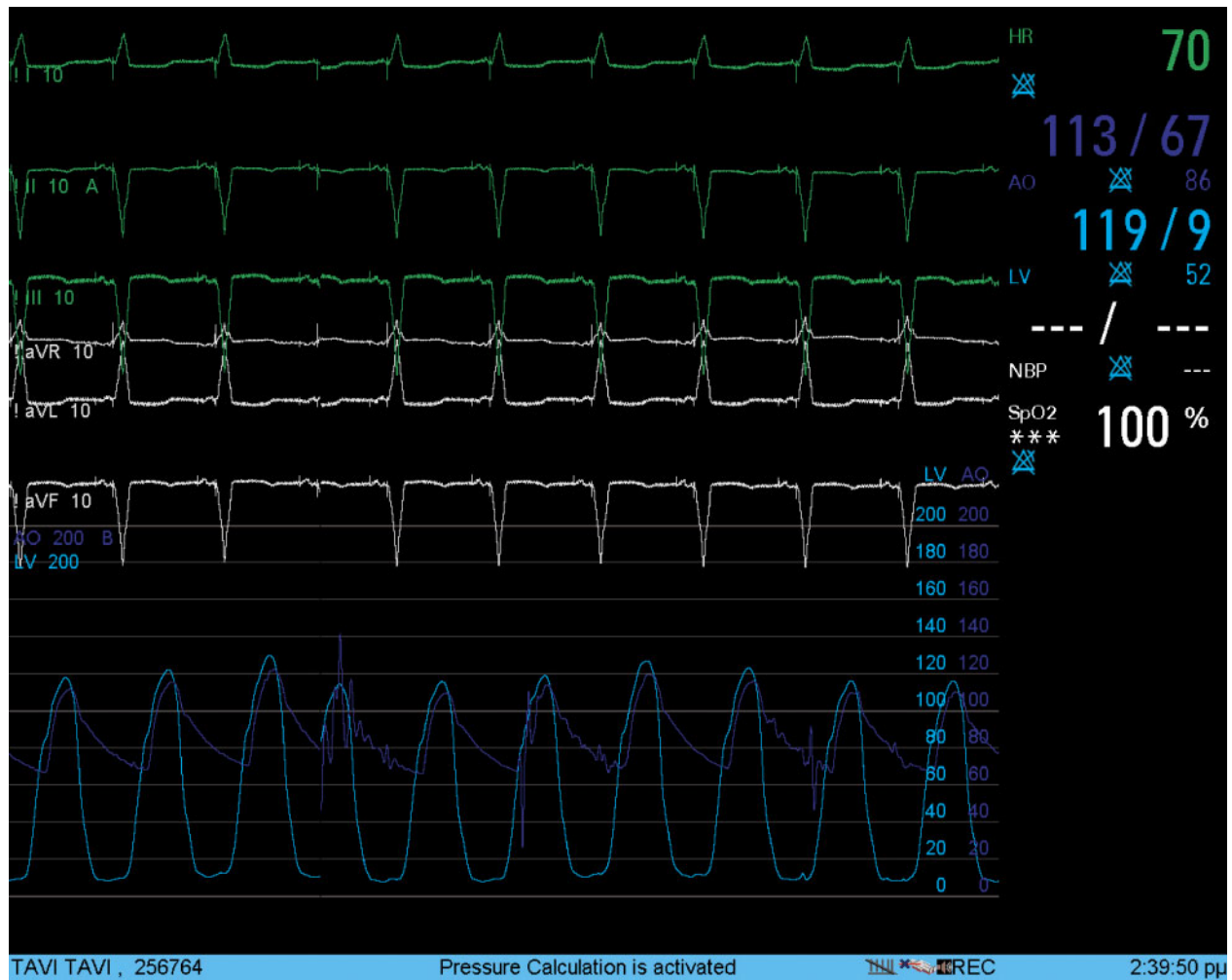


Figure 4 Final haemodynamic result.

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Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as [Supplementary data](#).

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: none declared.

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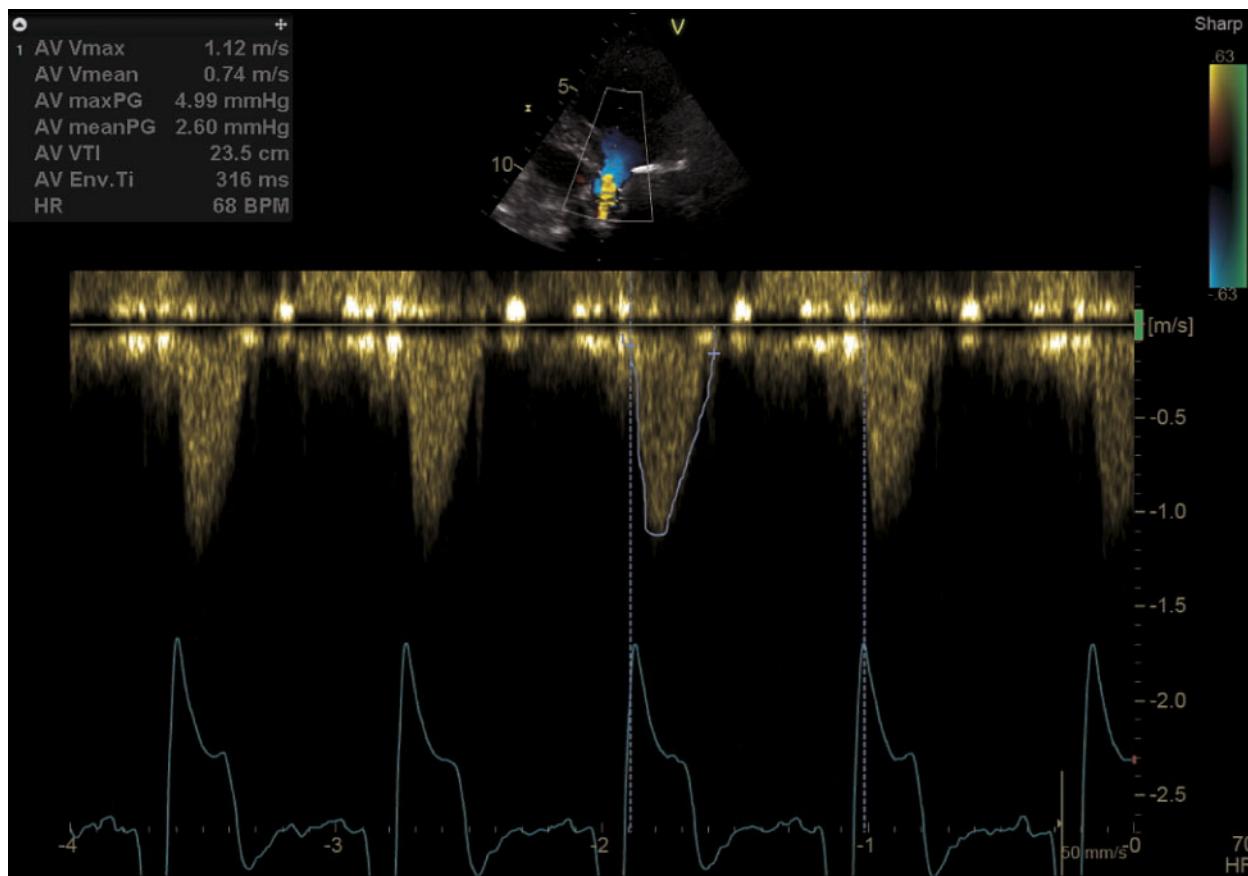


Figure 5 First month follow-up echocardiography.

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