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Valve geometry assessment during transcatheter tricuspid valve replacement offered by large field-of-view intravascular ultrasound

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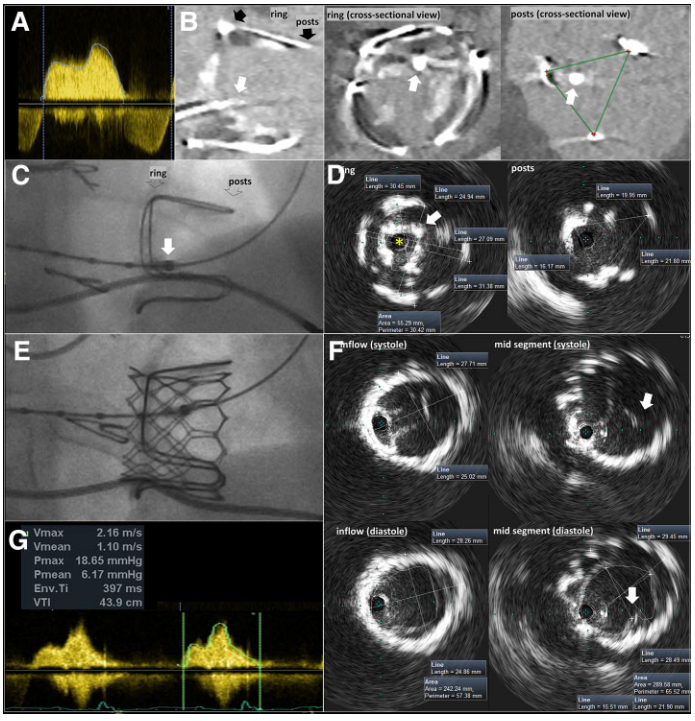

Figure 1 Baseline trans-valvular transthoracic echocardiography Doppler (*A*), computed tomography angiography (*B*), fluoroscopy (*C*) and intravascular ultrasound images (*D*) of failed 31 mm Carpentier-Edwards bioprosthesis. Corresponding fluoroscopy, intravascular ultrasound, and transthoracic echocardiography Doppler results recorded post valve-in-valve transcatheter tricuspid valve replacement using the SAPIEN 3 29 mm (*E–G*, *respectively*).

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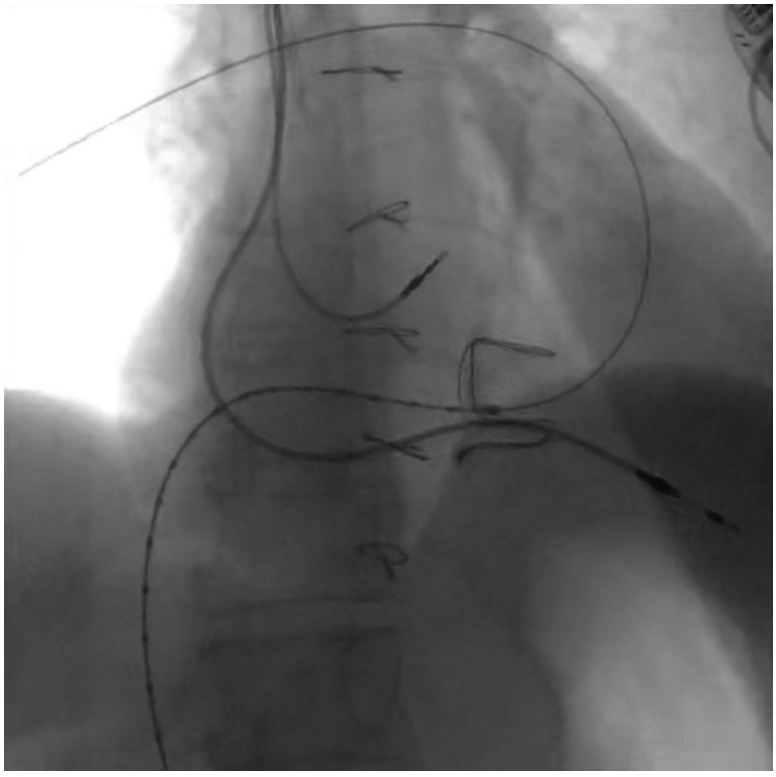
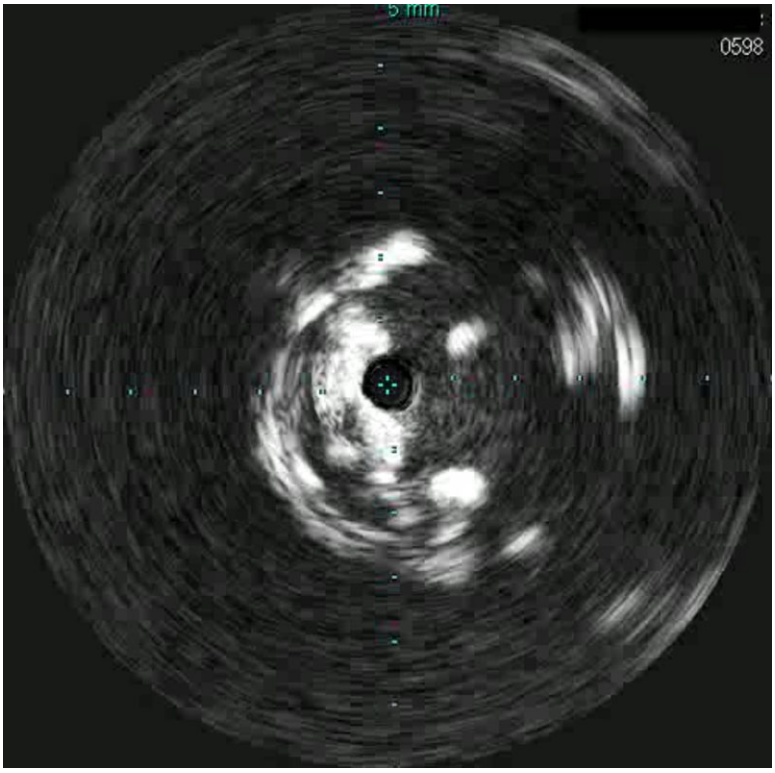
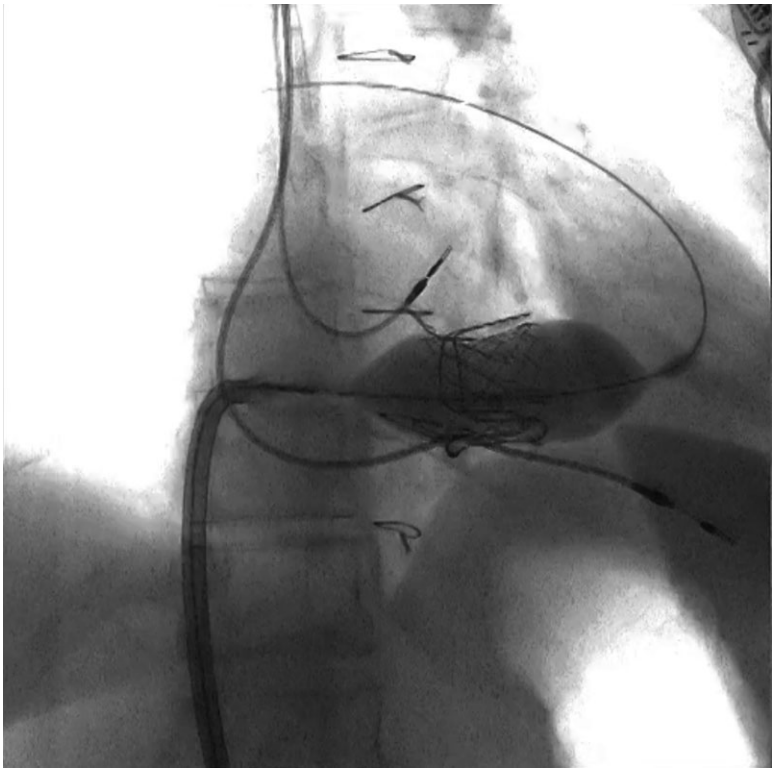
A 59-year-old woman with Ebstein's anomaly treated with surgical implantation of a 31 mm Carpentier-Edwards bioprosthesis in 1987 and with implanted dual-chamber permanent pacemaker (PPM) in 2003 presented with progressive dyspnoea occurring at minimal physical activity. Transthoracic echocardiography (TTE) revealed severe prosthetic heart valve (PHV) stenosis (max/mean diastolic gradient of 28.9/14.5 mmHg) and mild insufficiency (*Figure 1A*). EuroSCORE II was 3.0%, but due to PPM, comorbidities, and frailty, the patient was Heart Team qualified for valve-in-valve transcatheter tricuspid valve replacement (VIV-TTVR) using an Edwards SAPIEN 3 29 mm transcatheter heart valve (Edwards Lifesciences Corp., Irvine, California, USA). Baseline computed tomography angiography (*Figure 1B*) revealed calcified and immobile PHV leaflets with inner ring diameters of 24.6 × 27.4 mm and outer diameter of 31.4 mm. Since abnormally increased residual gradients are reported in 60–80% of VIV transcatheter valve replacements done with routine transoesophageal echo (TOE) guidance and given our recent experiences documenting a unique peri-procedural *tomographic* perspective offered by a Vision PV035 10 MHz intravascular ultrasound (IVUS: a 60 mm imaging field, tracking over an 0.035″ guidewire, Philips North America Corporation, Andover, MA), we used IVUS for the most accurate insight into the actual valve frame expansion not offered by TOE (*Figure 1C* and *Video 1*, *white arrow indicates the transducer location parallel to the PHV long-axis*).[1–3] It showed highly calcified and immobile PHV leaflets with geometric orifice area (GOA) of 55 mm^2 and inner ring dimension of 24.9 × 27.1 mm and outer diameter of 31.4 mm (*Figure 1D* and *Video 2*, *asterisk indicates IVUS transducer and arrow indicates traversing pacemaker lead*). SAPIEN 3 valve was deployed after pre-dilation using a 25 mm low pressure balloon (invasively measured residual diastolic gradient of <2 mmHg; *Figure 1E* and *Videos 3* and *4*). Corresponding post-procedural IVUS (*Figure 1F* and *Video 5*) revealed the valve inflow stent frame (overlapping PHV ring) to be elliptical with outer frame diameters of 25.0 × 27.7 mm (eccentricity index of 1.11) and 85% expansion of its outer frame nominal area (556/660 mm^2), whereas the valve mid segment was round (28.5 × 29.5 mm) with 96% expansion (633/660 mm^2, *Figure 1F*). All three leaflets of the valve were clearly seen at their base (valve inflow) and coaptation site (valve mid segment) in systole and diastole. The angles between the neo-commissures were not perfectly uniform in appearance (*Figure 1F*, *white arrows indicate a pinwheeling sign*). GOA measured in diastole at the valve inflow was 242 mm^2 and was 290 mm^2 at the mid valve segment (*Figure 1F*). Despite the suboptimal valve expansion, corresponding diastolic gradient assessed invasively and in TTE under general anaesthesia was <2 mmHg. Post-dilation was omitted. However, the next day TTE measured residual max/mean diastolic gradient was 18.7/6.2 mmHg (*Figure 1G*).



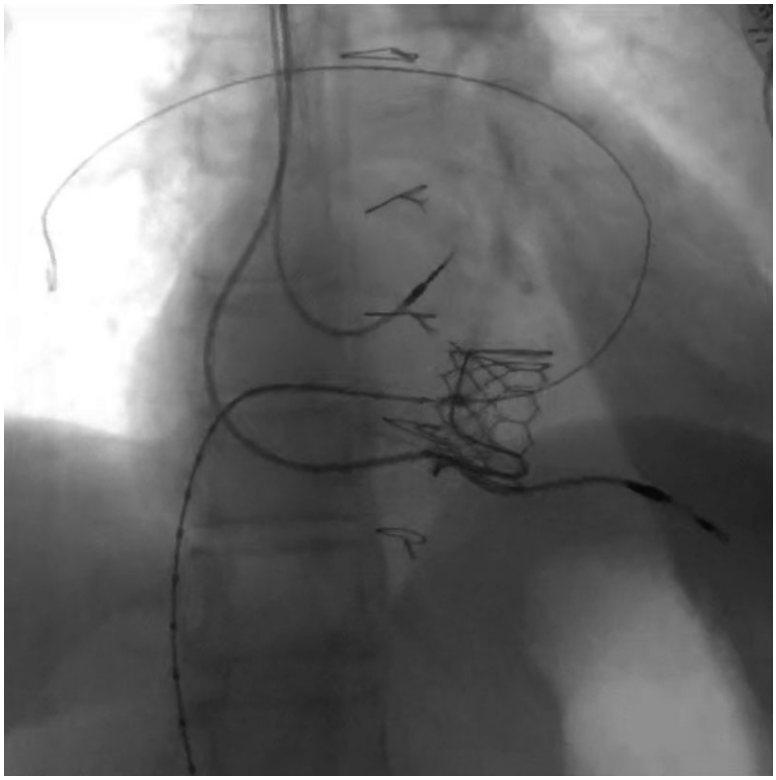
Video 1 Fluoroscopy prior to transcatheter heart valve (THV) deployment.



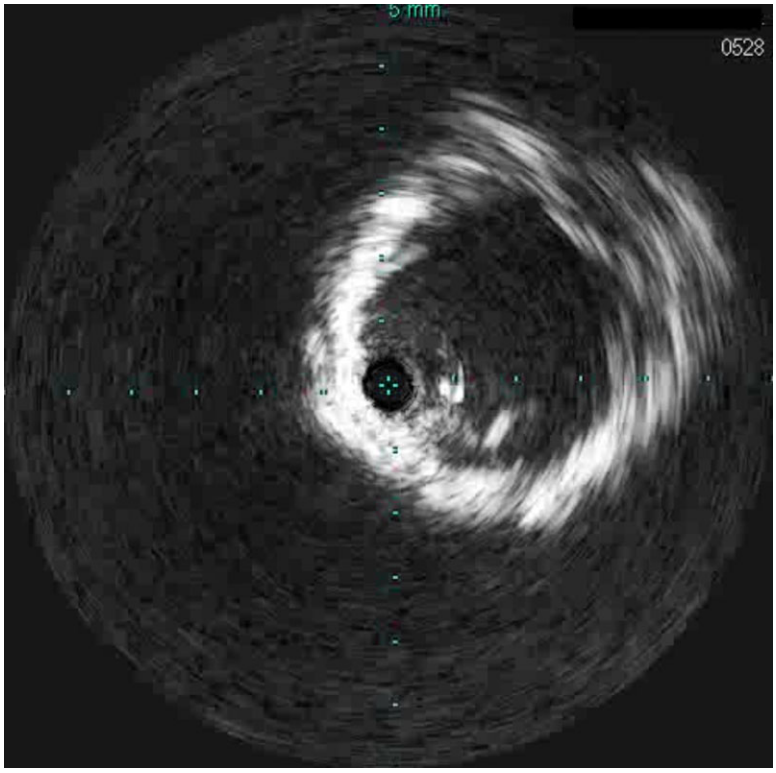
Video 2 Intravascular ultrasound prior to THV deployment.



Video 3 THV deployment in fluoroscopy.



Video 4 Fluoroscopy after THV deployment during IVUS examination (note the transducer location parallel to the THV long-axis).



Video 5 Intravascular ultrasound after THV deployment.

Lead author biography

Dr Łukasz Kalińczuk, MD, PhD, is an interventional cardiologist in Warsaw, Poland. Recently trying to adopt intravascular ultrasound in structural heart disease. Measured in IVUS detailed parameters of complex three-dimensional valve geometry are in line with suboptimal pattern of blood flow seen in the next day TTE, despite VIV-TTVR was finished with the absence of residual gradient as assessed under general anaesthesia.

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Consent: The authors confirm that written consent for submission and publication of this case report (including images and associated text) has been obtained from the patient in line with guidelines of Committee on Publication Ethics.

Conflict of interest: None declared.

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Data availability

The authors confirm that the data supporting the findings of this study are available within the article.

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