A 7-year-old patient (28 kg) born with aortic stenosis, having undergone the Ross procedure and a repeat surgical intervention including patch plasty of the stenosed conduit and mechanical valve implantation in the mitral position, presented with recurrence of right ventricular outflow tract conduit narrowing.

Transthoracic echocardiography showed obstruction of the conduit ($V_{max} = 4 \text{ m/s}$) with moderate pulmonary regurgitation. Cardiac computed tomography confirmed stenosis of the graft with a minimum diameter of 12×18 mm, unobstructed pulmonary arteries, and coronary arteries sufficiently separated from the graft.

The computed tomography scan was uploaded to the dedicated workstation for processing with the novel VesselNavigator (Philips Healthcare) 3-dimensional (3D) image fusion software. The automatically created 3D reconstruction was manually modified with a single-click segmentation tool (Figure [A]) to expose the right ventricular outflow tract and the left coronary artery (Figure [B], white arrows). The mechanical mitral valve was marked with a blue ring (Figure [B]; Movie I in the Data Supplement), and another ring (Figure [C]) was placed on the pulmonary artery bifurcation to mark the most distal position for the planned stent placement. The 3D reconstruction was manually fused with 2D fluoroscopy images (2D–3D registration), with spinal bodies (Figure [D]) and the mitral valve ring (Figure [E] and [F]) serving as reference points.1

A 39-mm Cheatham platinum stent (NuMED, Inc) was delivered (Figure [E]) and implanted (Figure [F]) into the conduit with the exclusive guidance of the 3D roadmap (Movie I in the Data Supplement).2 Next, a 20-mm Ensemble delivery system (Medtronic, Inc) was used to deploy a Melody valve (Medtronic, Inc; Figure [G]; Movie I in the Data Supplement). The fluoroscopy and procedural times were 23 and 110 minutes, respectively. The radiation dose, presented as dose area product, was 4570 $\mu \text{Gy} \cdot \text{m}^2$. Control echocardiography showed traces of pulmonary regurgitation with a maximum Doppler velocity across the right ventricular outflow tract of 2.2 m/s.

This novel 3D image fusion tool allows the utilization of preregistered data sets for easy precatheterization segmentation of target structures and quick and reliable manual fusion with 2D fluoroscopy images. The accuracy of 3D reconstruction overlay still has to be critically evaluated for each target structure, and appropriate corrections need to be made to accommodate distortion produced by pulsatility, cardiac motion, and respiratory motion. However, the possibility to place ring markers to mark the landing zone, or the origin of pulmonary artery branches, may increase confidence in positioning stents with no additional contrast injections. This imaging offers the potential benefit of shortening the diagnostic part of the procedure and providing reliable guidance during device delivery and implantation. Further prospective studies to assess full benefits of this new tool are warranted.

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Disclosures

None.

References


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Figure. VesselNavigator-assisted percutaneous pulmonary valve implantation in a 7-year-old patient after Ross procedure with repeat conduit obstruction. Automatic 3-dimensional (3D) reconstruction (A, left) and row scans (right) from preregistered computed tomography were manipulated to outline the conduit, proximal pulmonary arteries (B and C), and the left coronary artery (B, white arrows). The mechanical valve in the mitral position was marked with a blue ring (B) to enhance manual 3D image fusion with live fluoroscopy. Another ring (C, green) was placed at the level of the pulmonary artery bifurcation to aid stent positioning. Spinal bodies and proximal vertebrae were overlaid and manually aligned on fluoroscopy images registered in 2 perpendicular projections (D). The 3D roadmap was used to guide stent introduction (E), implantation (F) and positioning, and the deployment of a Melody valve (Medtronic, Inc; G).
Novel 3-Dimensional Image Fusion Software for Live Guidance of Percutaneous Pulmonary Valve Implantation
Sebastian Goreczny, Pawel Dryzek and Tomasz Moszura

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