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First-in-man intravascular ultrasound guidance of percutaneous pulmonary valve implantation

Łukasz Kalińczuk, Katarzyna Biernacka, Witold Rużyłło, Marcin Demkow

Institute of Cardiology, Warsaw, Poland

A 25-year-old male with dextro-transposition of the great arteries underwent a Rastelli procedure at the age of four. Nineteen years later, he underwent surgical pulmonary homograft replacement (ø25-mm) plus proximal insertion of a ø26-mm conduit. One year later, echocardiography showed distal pulmonary homograft stenosis with normal pulmonary valve function. A bare-metal 36-mm stent (Ev3 IntraStent LD Max, Plymouth, MN, USA) was deployed (@6 atm) on a 24-mm balloon-in-balloon catheter (BIB, NuMED, Hopkinton, NY, USA) at the distal anastomosis site and post-dilated (@8-atm) with an 16-mm ultra-high-pressure balloon (Mullin-X™, NuMED, Hopkinton). Right ventricle pressure remained 84/0–21 mmHg with an angiographic 34% diameter stenosis (DS) at the proximal stent margin (Fig. 1A). Computed tomography revealed the homograft minimal lumen site dimensions of 7.2 × 15.4-mm (65% DS), identified at the proximal stent edge near the pulmonary annulus (Fig. 1B). The homograft outer diameters were of 18.9 × 23.7--mm (Fig. 1B). Intravascular ultrasound (IVUS) with Visions® PV.035 Digital Catheter (Philips) revealed corresponding minimal lumen cross-sectional area (MLA) of 0.97-cm^2 (11.5 × 12.3-mm) with homograft outer dimension of 17.9 × 24.9-mm (Fig. 1C). The Melody™ transcatheter pulmonary valve (Medtronic, Minneapolis, Minnesota, USA) was deployed on a 22-mm balloon after landing-zone pre-stenting with IntraStent on 20-mm BIB (overlapping the first stent distal margin). Despite a good angiographic result (Fig. 1D), IVUS MLA was 1.58-cm^2 (15.0 × × 15.6-mm); thus, it was post-dilated using a 20-mm (@6-atm) and 22-mm Mullins-X™ balloon (@11--atm). Final MLA was of 3.16-cm^2 (19.5 × 20.2-mm; 0% DS), with a substantial increase in total homograft dimension and right ventricle pressure drop to 37/0–4 mmHg (Fig. 1E).

The study complied with the Declaration of Helsinki, the patient signed informed consent, and the study was approved by the local ethics committee.

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Conflict of interest: Marcin Demkow is proctoring for Medtronic. All the other authors have no conflicts of interest with regard to this manuscript.

Address for correspondence: Łukasz Kalińczuk, MD, PhD, Institute of Cardiology, ul. Alpejska 42, 04–628 Warszawa, Poland, tel/fax: +48 505 794 691/+48 22 34 34 528, e-mail: lukasz.kalinczuk@gmail.com

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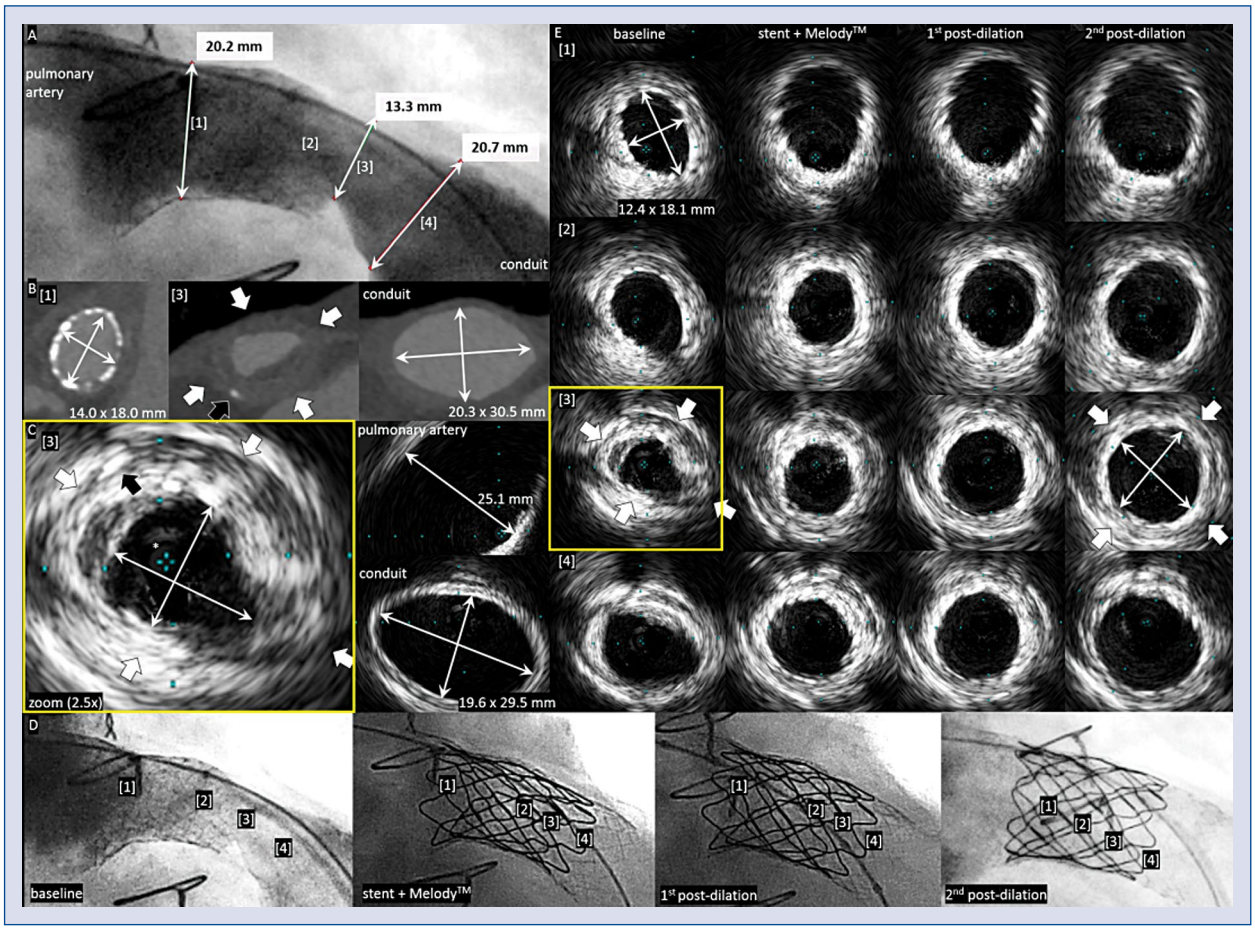

Figure 1. Corresponding angiography, computed tomography and intravascular ultrasound (IVUS) images; **A.** Angiography of the pulmonary homograft with indicated lumen diameters (white thin two-headed arrows) measured: distally [1]; at the minimal lumen site [3]; and proximally [4]; **B.** Computed tomography cross-sections perpendicular to the homograft long lumen axis obtained: distally (with indicated minimal and maximal in-stent diameters) [1]; at the site of homograft minimal lumen cross-sectional area (with its outer dimension marked with bold white arrows and a calcium deposit indicated with a black arrow) [3]; and within the conduit length (arrows indicate the relevant lumen diameters); **C.** IVUS recorded at the site of homograft minimal lumen cross-sectional area, with indicated minimal and maximal lumen diameters (white thin two-headed arrows) and its outer dimension (bold white arrows) [3]. The distal pulmonary artery and the conduit lumen diameters were also measured; **D.** Serial angiographies recorded at baseline, post pre-stenting and Melody™ deployment, and finally after the two sequential post-dilations; **E.** Serial IVUS images of the corresponding homograft sites, with measured: baseline minimal and maximal in-stent diameters (white thin two-headed arrows) distally [1]; the homograft outer dimensions assessed at the site of its minimal lumen cross-sectional area at baseline and post-procedure (bold white arrows) [3]; final in-valve minimal lumen cross-sectional area (white thin two-headed arrows) [3].