STUDIUM PRZYPADKU / *CLINICAL VIGNETTE*

Holographic imaging during transcatheter aortic valve implantation procedure in bicuspid aortic valve stenosis

Wykorzystanie hologramu podczas przezcewnikowego wszczepienia zastawki aortalnej u pacjenta ze stenozą dwupłatkowej zastawki aortalnej

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We present a case of an 80-year-old male patient with symptomatic aortic stenosis, admitted to the 1st Department of Cardiology, Medical University of Warsaw for valve replacement. His prior medical history included: non-obstructive coronary artery disease, transurethral prostatectomy, right-sided hernia, and right-sided nephrolithiasis surgery. Transthoracic echocardiography showed mean aortic pressure gradient of 40 mm Hg, aortic valve area (AVA) of 0.77 cm^2, and peak velocity of 4.3 m/s. For precise aortic annulus measurement, transoesophageal echocardiography (TEE) and a multi-sliced computed tomography (MSCT; Fig. 1) scan were performed. On TEE the aortic annulus perimeter was 83 mm, with diameters 24 × 29 mm. On MSCT annulus perimeter was 87 mm with diameters of 23 × 32 mm. Both imaging techniques revealed that the patient had bicuspid aortic valve with raphe between left and right coronary cusps (Type I L-R) and protruding calcium to the left ventricular outflow tract. The "prospected" annulus perimeter based on MSCT was 79.3 mm. The patient was referred by the local Heart Team to transcatheter aortic valve implantation (TAVI) via the femoral route. To better visualise the complex anatomy of the patient with bicuspid AS the use of holographic imaging was applied. *CarnaLife Holo*® (MedApp S.A., Krakow, Poland) visualises the individual patient's heart as an interactive holographic image based on computed tomography (CT) or a magnetic resonance imaging (MRI) scan of the patient (Fig. 2A–C). Possible interactions using voice commands and hand gestures include visualising the structure of the heart (3D), also during its cardiac cycle (4D), slicing, and partitioning. Users see and interact with those images via a *Microsoft HoloLens*® head-mounted display (Fig. 2D), which creates the visual illusion of a solid 3D object by recreating depth cues (perspective, occlusion, convergence, and parallax). The software supports loading of the medical data sets in common DICOM file format and adjusting the transfer function to achieve effective visualisation of skin, hard tissues like bones, and soft tissue organs like heart, based on methods well-established in the medical visualisation field. This method allows for the use of raw medical data acquired from CT and MRI devices, in contrast to the common approach with additional surface reconstruction to polygonal models, as in the case of typical surgery approaches with head-mounted displays. The periprocedural use of *CarnaLife Holo*® enabled the operator to view holographic image during the course of the procedure, facilitating precise visualisation of the aortic root. Ultimately the patient was implanted with a 29-mm Evolut R (Medtronic Int.) valve with small paravalvular leak (AVA 1.74 cm^2, mean pressure gradient 9 mm Hg, Vmax 2.4 m/s) and no conduction disturbances. The patient was discharged home on day 2 after the procedure in good clinical condition.
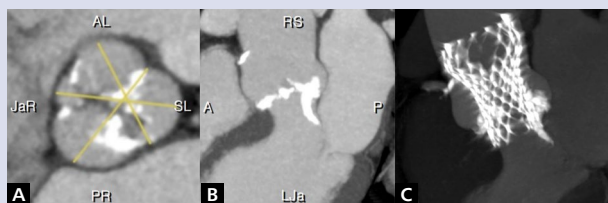

Figure 1. Multi-sliced computed tomography (MSCT) curved three-dimensional multiplanar reconstruction (3D MPR); **A.** Cross-section of the aortic valve at the level of the sinus of Valsalva showing bicuspid anatomy with raphe between left and right coronary cusps; **B.** Preprocedural 3D MPR maximal intensity projection (MIP) showing heavily calcified aortic valve with calcification extending into the left ventricular outflow tract; **C.** Post-procedural 3D MPR MIP with correct apposition of implanted bioprosthesis
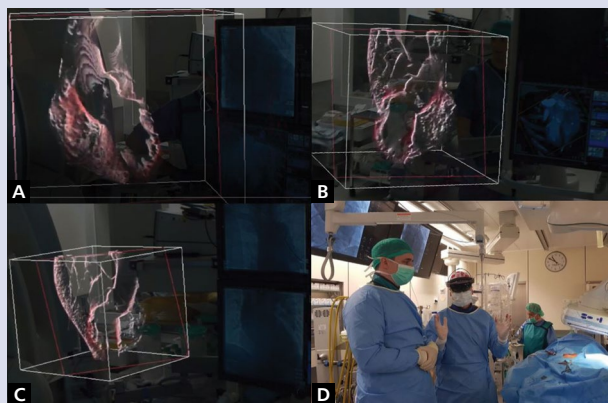

Figure 2. A–C. Holographic images of the heart and aortic valve anatomy as seen by the operator wearing *HoloLens*® headset; **D.** View of the operating room with operator interacting with holographic imaging

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