Mixed reality interactive visualization of cardiovascular anatomy in interventional lab – clinical implementation in transvascular patent ductus arteriosus closure

J.D. Kasprzak[1], M. Kierepka[2], A. Zlahoda-Huzior[3], M. Stanuch[3], D. Zolna[2], J. Serafin[2], J.I. Kasprzak[2], J. Witowski[4], P. Lipiec[1], K. Wdowiak-Okrojek[1], J.Z. Peruga[1]

[1]Medical University of Lodz, Lodz, Poland; [2]MEDAPP SA, Krakow, Poland; [3]MEDAPP SA and AGH Univ. of Science and Technology, Krakow, Poland; [4]Jagiellonian University, Medical College, Krakow, Poland

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Aim: Three-dimensional (3D) noninvasively acquired datasets containing anatomical information about the heart are a modern option for procedural support during percutaneous cardiac interventions. We present initial experience of patent ductus arteriosus (PDA) closure with workflow integrated with innovative mixed reality display (MRD) to improve 3D perception and navigation in 3D computed tomography angiographic (CTA) datasets.

Methods: We report incorporation of intraprocedural mixed-reality display of segmented CTA (computed tomography angiography) data using a voice- and gesture controlled head-mounted display during routine percutaneous occlusions of PDA in adults. A dedicated software pathway was used for files conversion, real-time Wi-Fi streaming of 3D rendering from PC to device and manipulation of spatial data during the procedures.

Results: Pre-recorded CTA studies of aorta and ductus were manually segmented and uploaded into custom designed 3D DICOM for realtime export to MRD device. 3D holograms were successfully displayed during the procedure by commercially available head-mounted display allowing touchless control and image sharing within cath-lab. Wiring of PDA aortic orifice was assisted by 3D hologram controlled by the imaging specialist and shared by the operator. Thus, MRD using evolving versions of custom software was successfully executed with segmented data presented as a semitransparent cubic hologram positioned in a convenient part of visual field allowing real-world action and with touchless control by medical team. Operator appreciated the use of MRD hologram realistically visualizing spatial relationships as practical aid to establish anatomical relationships and facilitate entry into ductus orifice. Procedures were successfully completed using arteriovenous guidewire loop to implant vascular occluders.

Conclusions: We demonstrate the methodology and software evolution (segmentation, data fusion) allowing practical implementation of intraprocedural mixed reality display of 3D CTA data, with sterile, touchless control of holographic image shared by interventional and imaging team to support percutaneous PDA closure.