CLINICAL VIGNETTE

Cardiac resynchronization device implantation supported by augmented reality visualization of computed tomography angiography reconstruction of the coronary sinus bed: the use of the Carna Life system

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Cardiac resynchronization therapy (CRT) is an established treatment for patients with heart failure with low left ventricular (LV) ejection fraction (LVEF) and prolonged QRS duration. However, up to 2% to 5% of implantation procedures fail, mostly because of anatomical reasons and excessive fluoroscopy use. A 68-year-old man with ischemic cardiomyopathy, history of congestive heart failure, New York Heart Association functional class II, sinus rhythm with a left bundle branch block (QRS, 170 ms), and an LVEF of 30%, was referred for CRT. Computed tomography angiography with reconstruction of coronary veins was performed before the procedure and confirmed a typical coronary sinus (CS) ostium with a diameter of 7×11 mm and at least 2 branches to be considered for LV lead placement. A 3-dimensional (3D) model of the venous system was created and displayed using augmented reality visualization with the Carna Life system (MedApp, Kraków, Poland). The procedure was performed with augmented reality glasses (head-mounted HoloLens® display; Microsoft, Redmond, Washington, United States) (FIGURE 1A) that allowed the operator to use hand gestures to locate CS visualization in a favorable place in space (FIGURE 1A–1C). The CRT implantation procedure was typical. After the placement of a single-coil DF-4 defibrillation lead in the apex region of the right ventricle and of an atrial lead in the right atrial appendage, the venous access was obtained via the left subclavian vein puncture and the CS was cannulated with a Selectra Hook-45 guide catheter (Biotronik, Berlin, Germany). Simultaneously, the operator had a CS hologram overlapped on a fluoroscopy display (FIGURE 1B), with a possibility of rotation, relocation to any place in space, and zooming with virtual finger moves (FIGURE 1C). As routine coronary venography was recorded, the operator could compare this image with the 3D visualization and predict the target vein to facilitate the access. The complex evaluation of a favorable venous anatomy was followed by quadripolar LV lead insertion (Sentus OTW-L QP; Biotronik, Berlin, Germany) into the mid-lateral vein, with optimal pacing parameters. A CRT device, Intica 7 HF-T QP (Biotronik, Berlin, Germany), was implanted.

During CRT implantation, difficulties may occur, some of which are related to venous abnormalities, limitation of fluoroscopy visualization, and its reliability. Augmented reality reconstruction has its own limitations, mainly attributed to the accuracy of a computed tomography scan; however, a simultaneous use of both visualization techniques may improve anatomical evaluation of the CS. It can be especially useful in venous tortuosity and kinky veins,

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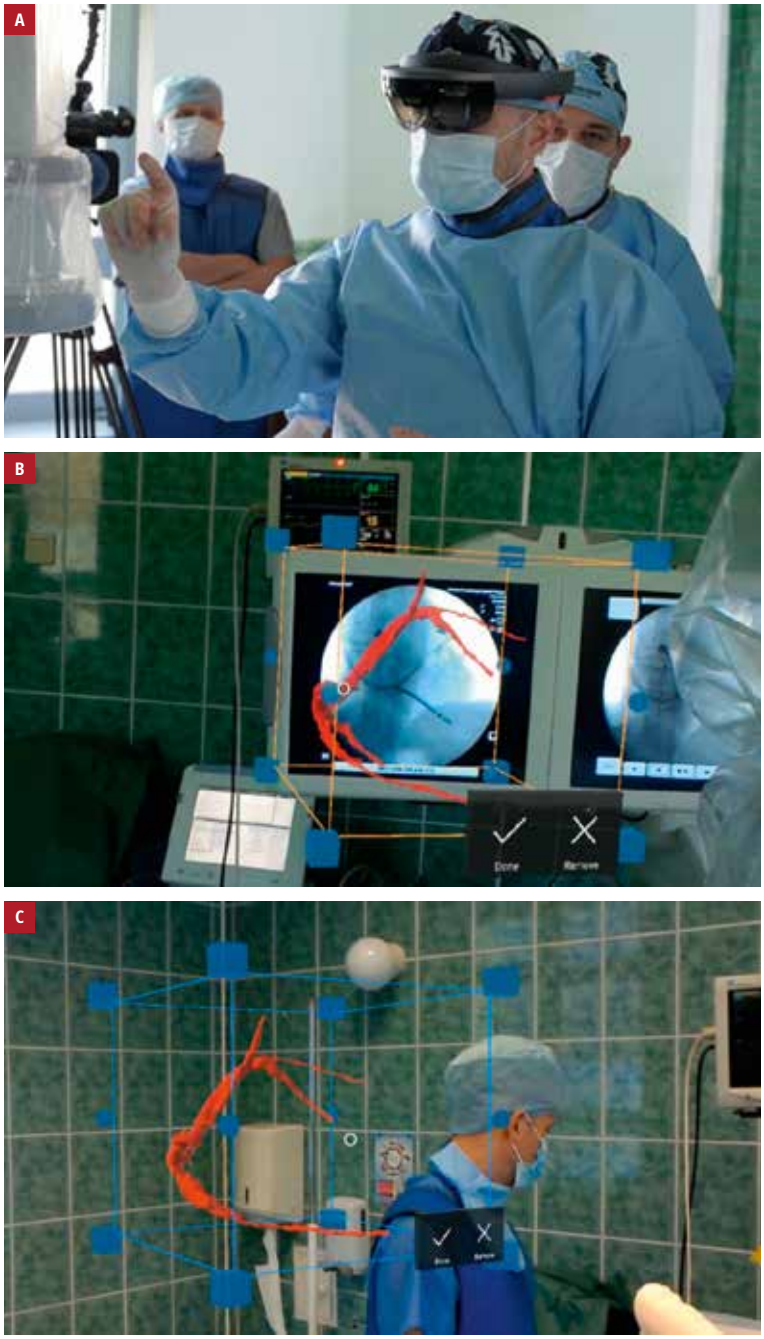

FIGURE 1 A – the operator wearing the HoloLens glasses is making virtual finger moves in augmented reality visualization in space; **B** – spatial augmented reality visualization of the coronary sinus, which was scaled and repositioned in a favorable place in the operating room, using virtual hand gestures; **C** – an overlap comparison of classic fluoroscopic venography of the coronary sinus bed and augmented reality visualization of its 3-dimensional reconstruction

or when the CS ostium can be hardly cannulated. The HoloLens® system did not limit the operator's vision and enabled a transparent, global view. The use of augmented reality 3D reconstruction may improve the efficacy of CRT implantation, shorten the procedure time, and allow a reduction of total fluoroscopy dose, but further studies are needed to confirm this hypothesis. To our best knowledge, we describe the first use of HoloLens for a CRT procedure.

ARTICLE INFORMATION

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