A platform for real-3d visualization and planning of left atrial appendage occlusion through mixed reality

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Background: In left atrial appendage occlusion (LAAO), pre-procedural computed tomography (CT) is pivotal to describe the complex and highly variable LAA anatomy and to guide the operator in accurate planning of the intervention. Multiplanar reconstruction and 3D rendering are used for the navigation and analysis of the 3D datasets but they share some limitations that are due to the use of 2D screens; Mixed Reality (MxR) technology aims at overcoming such limitations by allowing for real-3D visualizations with holographic replicas of anatomical models while preserving a sense of presence within the true physical environment by the operator.

Purpose: To develop and test a MxR platform that provides a more intuitive and informative tool for the morphological analysis during the planning phase of LAAO.

Methods: Patients (n = 4) were randomly selected among those referred for a CT scan prior to transcatheter aortic valve replacement, each one characterized by a specific LAA morphology (cauliflower, bilobular, chicken wing, wind-sock). CT scans were performed in diastole at 75% of the R-R interval on a 64-slice scanner, with in-plane resolution 0.38-0.64 mm and slice thickness 0.62 mm. Firstly, the acquisition was cropped to contain the left atrium, the circumflex artery, the left upper pulmonary ridge. Subsequently, an isosurface with high coincidence between the blood cavity border and the endocardium was identified by the user and processed using a marching cube algorithm to obtain the 3D model. Finally, the 3D model was optimized for a MxR platform that allows for moving, zooming and cutting the model, measuring the main LAA linear dimensions and simulating the implant of a virtual replica of a transcatheter occluder.

Results:

The workflow was successfully applied for all the patients independently from the morphology. All the models were successfully uploaded in the MxR platform (Fig 1.a) and for all the patients the morphological analysis was performed (Fig 1.b) in less than 10 minutes.

The four different morphologies of the LAA were correctly identified allowing a very detailed holographic modeling of the structure, including the neck, the landing zone, the curvature and the position and size of lobes.

For both the identified ostium and landing planes, using a dedicated measuring tool (Fig. 1.c), the operator measured the minimum and maximum diameters, which were later used to define the size of the occluder device to be used in the virtual implant simulation (Fig. 1.d).

Conclusions: The tested MxR platform suggested the potential to overcome the limits of the standard technologies in planning of LAAO thanks to the real-3D perception, potentially leading to a more accurate and faster planning phase. Furthermore, the use of MxR technology may enhance the ability to predict the optimal device size and position within the anatomy to obtain LAA complete sealing.

Abstract Figure.

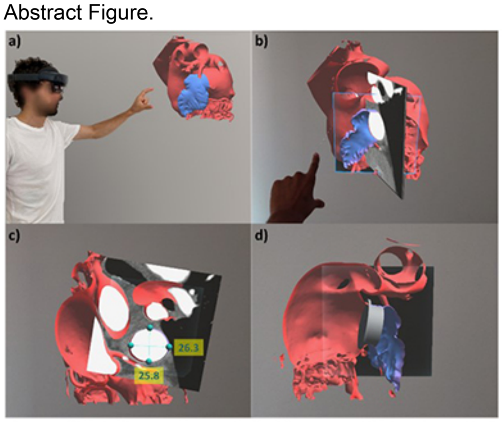

Figure 1 a) MxR application with a model of all the structures of interest displayed. b) Example of MxR interaction: cutting of the model and visualization of a slice extracted from the CT volume overlaid on the 3D model. c) Example of the MxR measuring tool: measurement of the landing plane maximum and minimum diameters. d) Example of virtual implantation of the occluder device inside the MxR model.