

Virtual Reality–Based Three-Dimensional Reconstruction of Fetal Echocardiography: Feasibility, Clinical Applications, and Translational Potential

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Objective

To investigate the feasibility and translational applications of the Elucis virtual reality (VR) software for segmentation and three-dimensional (3D) reconstruction of STIC echocardiographic volumes, and to assess its clinical, educational, and family counseling potential.

Methods

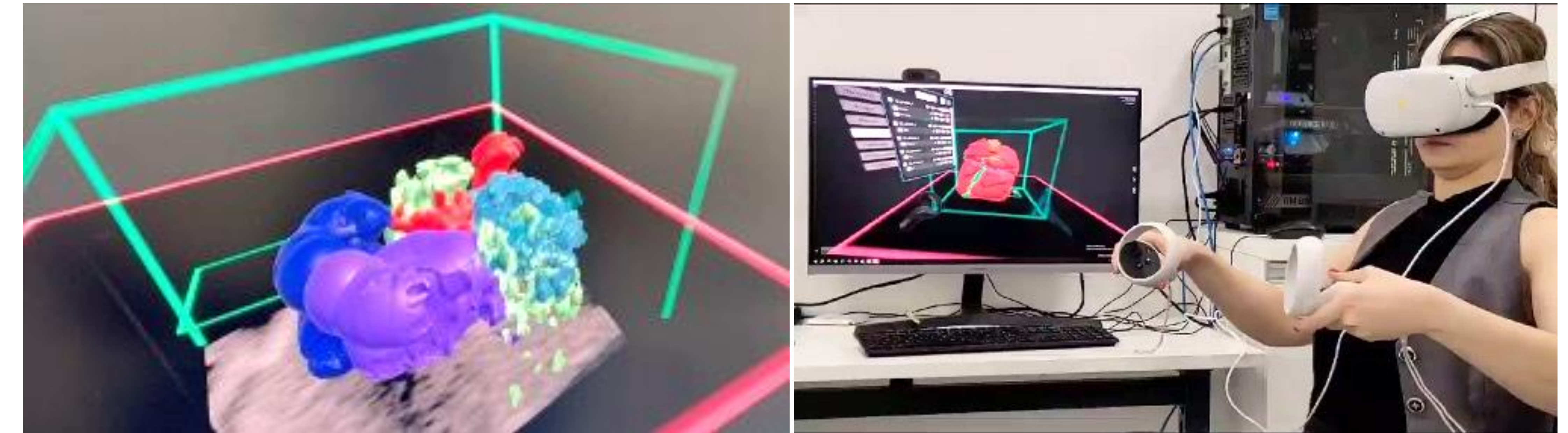
10 cases were evaluated. A standardized workflow was established, including file curation and conversion, volume alignment, anatomical mask creation, volumetric reconstruction with smoothing and noise reduction, and export of models for sharing or 3D printing. Reconstructed models were assessed by researchers specialized in fetal cardiology.

Results

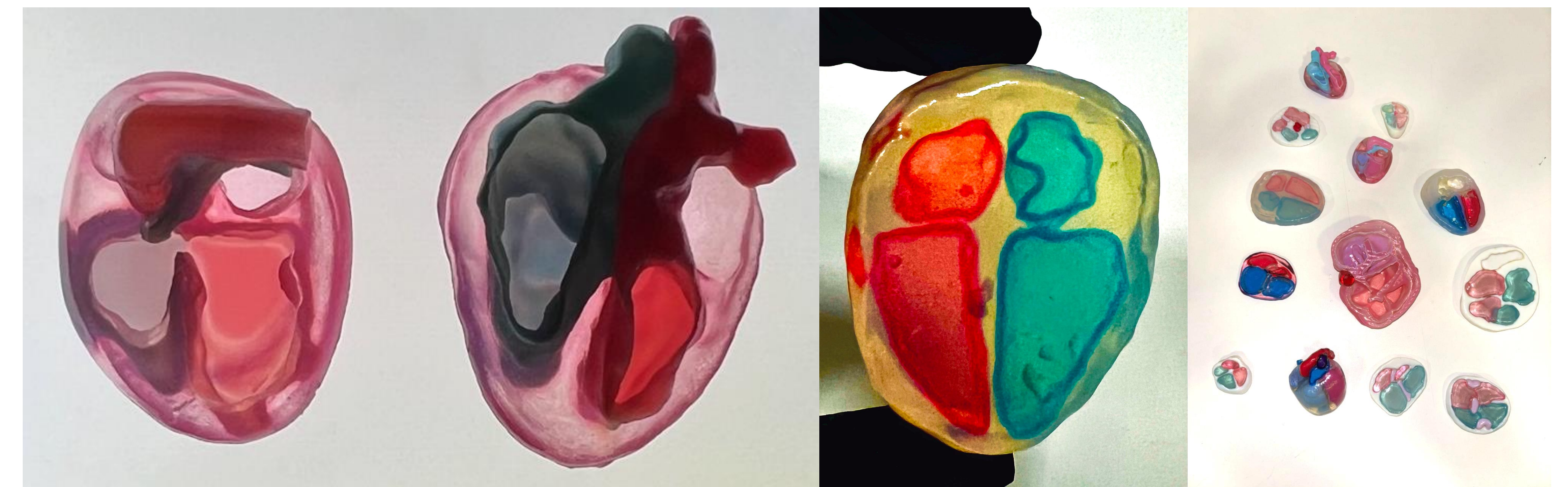
The reconstructed models were considered anatomically accurate by expert reviewers and proved useful for visualizing conditions such as muscular ventricular septal defect, transposition of the great arteries, Ebstein anomaly, complete atrioventricular septal defect, left ventricular diverticulum, crux cordis assessment, and fetal circulation. In challenging two-dimensional (2D) scenarios, immersive 3D visualization reduced diagnostic ambiguity and supported preoperative reasoning. Identified limitations included dependence on high-quality STIC acquisitions, a learning curve, software updates, and hardware costs.

Conclusion

Fetal heart segmentation using conventional 2D echocardiography presents inherent limitations that may hinder the spatial understanding of complex congenital heart diseases. VR-based 3D reconstruction of fetal echocardiographic volumes is feasible and provides clinically and educationally relevant anatomical information. This approach may enhance diagnostic confidence and support family counseling and surgical planning. Future studies are expected to consolidate multicenter adoption, particularly through the integration of artificial intelligence for assisted segmentation.



Virtual reality segmentation



Reconstructed models: Tetralogy of Fallot; transposition of the great arteries and Rhabdomyomas, and various others