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New Insights into Surgical Anatomy of Double Outlet Right Ventricle – An Echocardiography and 3D Model correlation study.

Yim D., Ide H., Dragulescu A., Van Arsdell G.S., Grosse-Wortmann L., Seed M., Yoo S.J.
The Hospital for Sick Children, Toronto, Canada

Introduction: Within the umbrella diagnosis of double outlet right ventricle (DORV), there is considerable heterogeneity of intracardiac anatomy. Precise 3-dimensional (3D) understanding of anatomy is crucial as complicated VSD baffling to an arterial trunk is often required. 3D-print cardiac models can provide a visual roadmap to assist with surgical planning.

Objective: To correlate transthoracic echocardiography (TTE) with 3D-print models and intra-operative findings and analyze discrepancies in the pre-surgical diagnosis between modalities. We sought to determine if 3D-print models affected anatomic diagnoses and decision-making.

Methods: Since 2009, 40 3D-print models with DORV were provided for clinical decision-making. We retrospectively reviewed TTE studies, models, intra-operative findings and final operative decisions.

Results: Anatomic characteristics included situs abnormalities (10%), dextrocardia (18%) and outflow tract obstruction (78%). Ventricular septal defects (VSD) were remote in 23%. Great artery relationships were malposed in 63%. There was a degree of discrepancy in 25% of cases between TTE and findings shown with 3D-print models and surgical reports, including inaccurate VSD description (13%), its commitment to arterial valve/s (8%) and mechanism of outflow tract obstruction (5%). The most significant contribution of 3D-print models was considered the apparent demonstration of the route for intraventricular baffling when echocardiographic findings were not completely conclusive. 3D-print models clearly showed the extent of the tricuspid valve annulus bordering the VSD margin, alignment of the VSD to arterial valve/s and extent of the muscular infundibulum. However, information regarding valves, chordae and papillary muscles was insufficient in 3D models.

Conclusion: 3D-print models provided indisputable information regarding cardiac anatomy, especially when the VSD involved the ventricular inlet or if the infundibulum was excessively long. Correlation of echocardiography with 3D models enhanced understanding of surgical anatomy and, therefore, improved surgical decisions with a higher level of confidence.

Figure: (A,B) Transthoracic echocardiographic images and (C) 3D-printed model of DORV showing subaortic obstruction from muscle bundles and posterior deviation of the outlet septum, with persistence of the ventricular infundibular fold (VIF). The ventricular septal defect (VSD) is aligned with the aortic valve. Intra-operative images before (E) and after (F) biventricular repair with subaortic resection and VSD closure. TV: tricuspid valve.