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3D “modeling” and “printing” based on MR and CT data in neonate with complex twisted heart: new frontier for clinical decision and optimal surgical approach

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Objectives: To produce a three dimensional (3D) anatomical prototype of the heart of a patient with complex congenital heart disease and evaluate clinical usefulness in determining the best therapeutic approach.
Methods: One neonate (male, 2.7 Kg) with Goldenhar syndrome, right lung hypoplasia, right sided heart, twisted supero-inferior ventricles with hypoplastic LV, aortic coarctation and large ventricular septal defect underwent computed tomography angiography (CTA) and cardiovascular magnetic resonance (CMR) in order to better define cardiovascular anatomy and hemodynamic consequence related to the complex malformation.
CTA was acquired using post-iodinate contrast ECG-gated high-pitch acquisition modality (Somatom Definition Flash, Siemens). CMR sequences were focused on the evaluation of anatomical morphology, flows and function. In particular, CMR anatomy was assessed using a 3D T1 turbo spin echo with respiratory triggering. Both CTA and CMR volumetric sequence were acquired in systolic phase avoiding the artefact due to ventricular tachycardia.
Data achieved from CTA and CMR were combined using a post-processing software (MIMICS, Materialise) in order to evaluate and isolate cardiac chambers, myocardium, great vessels and proximal coronary arteries.
Results: The left ventricle volumes (indexed LVEDV 21 ml/m2) and aortic forward flow (>1 l/min/m2) were considered adequate to support biventricular circulation with no evidence of endomyocardial fibroelastosis at late gadolinium enhancement imaging.
Stereolithography (STL) file was obtained from 3D data from CTA and CMR. Wall model was printed out with TuskT (rigid and trasparent) material and divided in three pieces in order to optimize intracardiac views and better define relationship between structures.
VSD septal defect, its margin and its relationship with surrounding structures such as outflow tracts, RV free wall and branching right coronary artery course were identified and three-dimensionally displayed. Surgical LV to aorta connectibility and VSD closure were considered feasible and biventricular repair was successfully performed.
Conclusions: Modern advanced integrated imaging approach supported by new 3D technologies provide additional insight into complex congenital heart disease in neonates, particularly in twisted or criss-cross heart. 3D print models can reduce uncertainties as regards to the patient’s specific anatomy and concretely help in the clinical decision-making.