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Utility of 3D printing techniques for Interventional planning

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Background: The spatial relationships of anatomical structures in patients with complex congenital heart disease (CHD) can represent a challenge for interventional planning. In these cases, cardiac magnetic resonance (CMR) and multi-detector computed tomography (MDCT) are diagnostic tools that provide information which can be reproduced in a 3D printed model to assess the feasibility of interventional treatment.
Methods: Interventional planning was reproduced in cases in whom cardiac catheterisation was controvertible using a patient-specific 3D printed heart model. Segmentation was performed from previous imaging acquired dataset using Mimics software v.18. Models were fabricated by polyjet technology or fused deposition modelling. Cardiac catheterisation was performed in the model before proceeding in the patient.
Results: Fifteen patients were referred for cardiac 3D printing (60% females; mean age:41 (1.5 – 65), 87% adults). Four patients had partial anomalous pulmonary venous drainage, three had transposition of the great arteries(TGA), four had coronary artery fistula, one had an aortic aneurysm post aortic valve replacement, one had tetralogy of Fallot(TOF) and one had multiple ventricular septal defects(VSD). 67% of the patients underwent cardiac catheterisation, 1 case with coronary fistula and one TGA (13%) were considered unsuitable after reviewing the model and 20% are awaiting further management.
LPA stenosis motivated printing for 2/3 of the patients with TGA and the TOF case. 3D models provided interventionalists with the opportunity to select stent length and size beforehand for all these cases. The remaining TGA had a previous atrial switch operation (Senning), developing a baffle leak that was considered unsuitable for stent closure as per the proximity of the defect to the mitral valve. All 3 coronary fistulas have successfully been closed. Occlusion of the aortic aneurysm was achieved using an AVP II device and a large VSD was closed with an amplatzer device in the case with multiple VSDs. All patients who underwent catheterisation were used had a successful result.
Conclusions: 3D models provide the opportunity to select materials and plan access routes before cardiac catheter intervention. This is beneficial where spatial complexity obstructs expert led treatment and interventional planning, providing the interventional cardiologist with confidence to address conditions that might otherwise be resolved with surgery.