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3D printing of heart with congenital heart disease-A case study

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Introduction: Objective of this study is to highlight the insight provided by patient specific 3D printed model of heart with congenital heart disease. The "3D printed physical model" provides detail morphological information for patient specific clinical management. The management of congenital heart disease includes invasive, non-invasive and catheter based intervention with accurate timing. "3D printed physical model" provides information for cardiologist and cardiac surgeons to manage patient from their perspective.

Method: A 5 month old boy with complex congenital heart disease with severe Pulmonary artery hypertension underwent assessment at our centre. Echocardiography revealed, heterotaxy, situs ambiguous, mesocardia, L-loop ventricles with L-posed aorta, common atrium, systemic venous anomaly in the form of interrupted IVC draining through azygous vein to the left sided SVC and hepatic veins draining into the right sided aspect of the common atrium (Fig.1) The pulmonary veins were lateralised. The baby had two good sized ventricles with large mid muscular VSD with severe right ventricular dilation.

CT scan was done to reconfirm the anatomy and subsequently 3D model was printed to aid in planning the surgical correction.The DICOM data set obtained from CT scan was processed to reconstruct a 3D digital model (Fig.2)using mimics software aided by skilful manual segmentation. The model was exported as STL file for 3D printing. The model was 3D printed by selective laser sintering of nylon powder (Fig.3). With Clinician's inputs, the model is pre-cut and built so as to maximise the visualisation of the defects (Fig.4). A virtual planning with a CAD generated surgical patch is also exported as STL and printed and is evaluated for its suitability on physical model

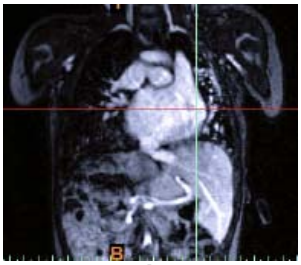

Fig. 1

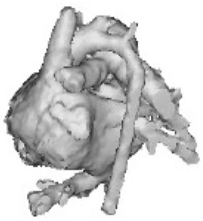

Fig. 2

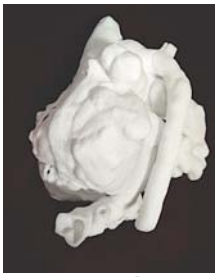

Fig. 3

Fig.4

Fig.1 CT scan reveling situs ambiguous, ASD, VSD; Fig.2 Reconstructed Heart model; Fig.3 SLS Nylon heart model; Fig.4 Cut Sectional model showing details

Results and Conclusions: Though the anatomy was confirmed by both echocardiography and CT scan the 3D model enabled us to visualise and strategise the way to close the VSD and baffle the systemic veins into the left sided pulmonary ventricle and pulmonary veins to the right sided systemic ventricle. It was more evident planning the baffle after studying the 3D printed model in depth.