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The use of 3D Printing in the Evaluation of Complex Congenital Heart Disease (CHD): Registry data from the European Congenital Heart Surgeons Association (ECHSA)

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Introduction: Three-dimensional printing (3D printing) of physical cardiac models is a new tool poised to help surgeons appreciate complex cardiac anatomic features and their interrelationships with surrounding tissues, as shown in various published case reports, but, objective evidence of the usefulness of this technology is lacking. We report preliminary analysis of data from an ECHSA multicenter retrospective registry, aiming to establish the usefulness of preoperative 3D Printing models in facilitating clinical decision making, as assessed by each contributing cardiac team.

Methods: In each participating center, accurate 3D printed models of the relevant cardiac anatomy were created based on contrast–enhanced computer tomography(CT) or magnetic resonance(MR) images in selected cases, as decided by the local cardiac team. The surgeons subsequently evaluated (on a scale 0-3) and reported the usefulness of the 3D printed models in 4 categories: a)Family education and counseling, b)Surgical or percutaneous interventional planning, c)Surgical teaching or simulation, and d)Evaluation of surgical/interventional result.

Results: From June of 2014 till December of 2017, 39 patients with anatomically challenging congenital heart defects, whose preoperative assessment included creation of 3D printed cardiovascular models, were enrolled from 3 different cardiac centers. Issues explored included feasibility of biventricular repair in complex DORV (n=6), approach to coronary anomalies (fistula(n=1), AAOCA(n=2)), technical demands of complex aortic (n=4) or pulmonary (n=3) reoperations, and PA-VSD-MAPCAS (n=5), technical demands of complex aortic operations (n=8), TGA's (n=3), single ventricle (n=1), PAPVC (n=1), Truncus(n=2), TOF (n=2), ASD (n=1). Each patient's care team retrospectively evaluated the usefulness of the model. In all cases, the 3D model facilitated diagnostic understanding (median score 3), surgical planning and patient/family education (median score 2), but in only a few cases (n=7) was it used for surgical teaching or simulation.

Conclusions: This study provides preliminary initial evidence favoring the clinical usefulness of 3D printed models in the management of complex CHD. Printing of 3D cardiac models appears to be a useful tool for the diagnostic assessment and preoperative preparations for patients with CHD's, as judged by the user physician teams. Enlargement of the database and incorporation of more objective assessment methods is warranted and is in evolution.