Preface

It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.

Mark Twain

True and accurate comprehension of cardiac anatomy in a patient with complex congenital heart disease is essential for appropriate presurgical planning. Although this concept is clearly not a point of debate, the discussion of whether or not one can truly grasp a patients three-dimensional (3D) anatomy from two-dimensional (2D) imaging data may be a point of contention. The current mainstay of diagnosing congenital heart disease and eliciting the details of intracardiac spatial relationships is 2D echocardiography. The evolution of echocardiography over the last 50 years has been tremendous, progressing from M-mode, to 2D echocardiography, color Doppler imaging, and 3D echocardiography. Pediatric cardiology trainees are taught to deduce anatomic relationships in space, as did their predecessors, using sweeps of the transducer from different positions on a patient's chest. In patients with complex congenital heart disease, such as double-outlet right ventricle, the path of a potential left ventricle to aortic baffle is primarily determined based on careful examination of a sweep in the subcostal view. The theoretical path is deduced on 2D images from posterior and inferior structures to those which are anterior and superior. While these images are presented in surgical conference, the assumption is that the audience, which consists of pediatric cardiologists, not all of whom are trained in imaging, surgeons, fellows, and echocardiography technologists are all recreating the same virtual cardiac anatomy in their mind. Given the lack of true 3D representation, it is difficult to imagine that this assumption would be accurate, especially given that people vary in their ability to translate 2D data into 3D. In cases for which further anatomic data are needed, cardiac computed tomography or magnetic resonance imaging is often applied. Although these modalities certainly offer the advantage of providing clear whole-heart datasets, we are again faced with the challenge of translating 2D imaging data or 3D renderings presented on a 2D screen. The advent of 3D printing technology allows for creation of 3D physical models using the method of stacking thin layers on top of one another to create a height, width, and length. When performed in a precisely defined pattern, a complex 3D structure can be printed. Using imaging datasets that possess 3D cardiac

spatial information, a virtual cardiac model can be used to create a physical model on a 3D printer. Given the significant time commitment needed to arrive at the final product, these models do not necessarily provide vital anatomic information for all patients with congenital heart disease. Those with the most severe anatomic abnormalities benefit the most at this time.

With the application of this technology within the realm of cardiac disease growing rapidly, I am confident that this text will serve as an informative reference guide. The topics covered speak to a diverse audience including pediatric and adult cardiologists, cardiothoracic surgeons, radiologists, biomedical engineers, and imaging technologists, many of whom may play a role in the workflow of 3D printing cardiac models. The wide range of expertise of the authors who contributed to this work serves to enhance the experience of the reader, offering insights ranging from the history of 3D printing and details of different additive manufacturing techniques to its applications in specific disease states and potential for utility in printing live tissue. I am hopeful that the enthusiasm of each contributor for this technology comes across to the reader, so that it strengthens the fervor of those who support it and persuades those who remain skeptical regarding its applications and substantial presence in the future of advanced cardiac imaging.

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