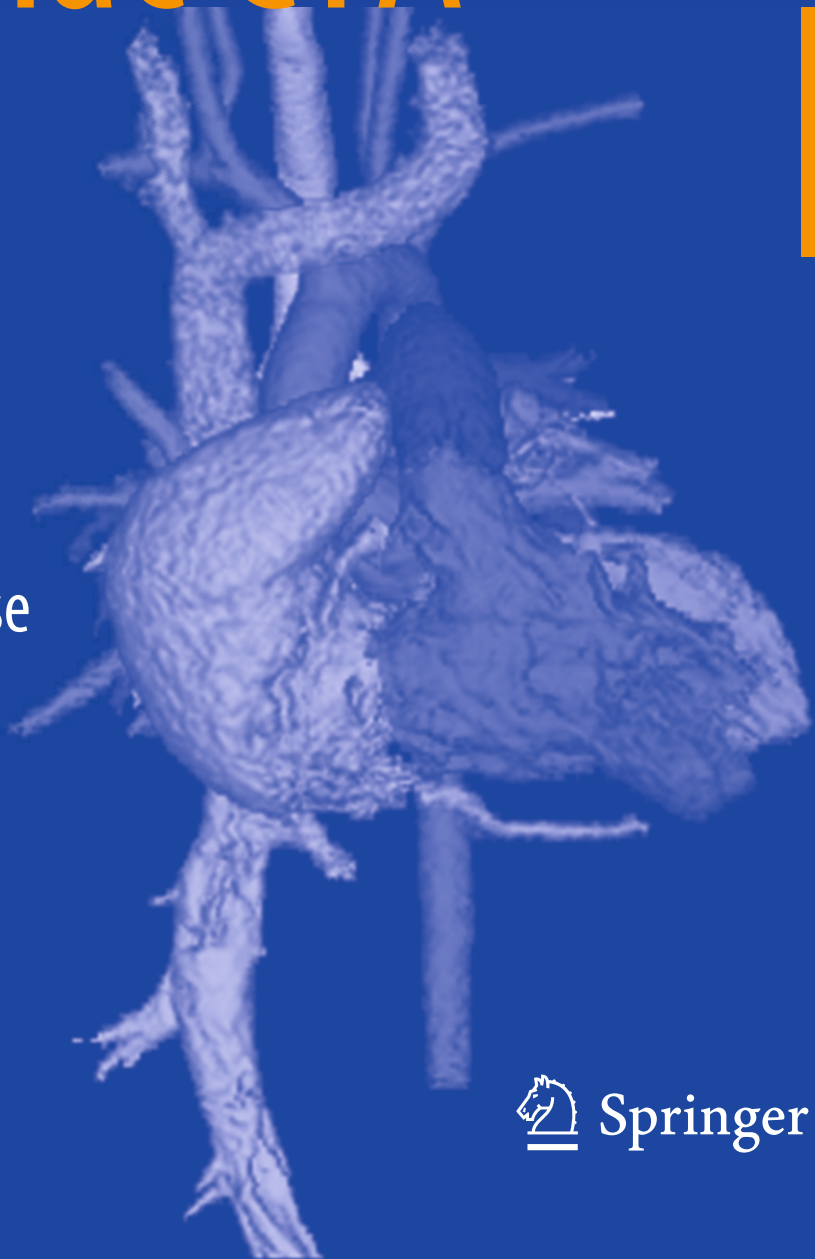
Randy Ray Richardson

Atlas of Pediatric Cardiac CTA

Congenital Heart Disease



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I would like to dedicate this book to my nephew, Mark Wright. Mark was born with hypoplastic left heart syndrome. He has spent months in the hospital with caring physicians and medical personnel who have helped him through multiple surgeries and procedures to develop a new physiology for his cardiovascular system. Fortunately for Mark, he has tolerated these surgeries and procedures well and is an active 4-year-old boy. It would be hard for anyone who didn't know his history to suspect he had any problems at all. As a radiologist, I rarely become emotionally involved in the lives of the patients I image. Mark helped me understand the myriad of emotions and stresses that a patient and his or her family go through as their child is treated for a serious congenital heart disease. Mark also helped me see the dedication of nurses and physicians who are so willing to give of their time and expertise, for which they never receive any monetary reimbursement. I am thankful for Mark, his family, and all those who participated in his care for teaching me these important lessons.

Fig. 1 Mark Wright (nephew) with oxygen tubing after his Glenn procedure, with cousin Riggs (behind)

Fig. 2 Mark Wright at the beach after his third major open heart surgery

Preface

Atlas of Pediatric Cardiac CTA is a concise visual guide to the imaging of congenital heart disease in infants and children. Using an organized, systematic approach accompanied with clinical examples, the book focuses on the utilization of cardiac CTA imaging for pediatric patients distinct from adult patients, with an emphasis on techniques for prospective versus retrospective gated imaging, radiation lowering, adaptive statistical iterative reconstruction (ASIR), and modulation. The post-processing of cardiac CT information is also discussed, a method that results in maximizing the amount of information provided to the clinician. The final section of the book presents a systematic cardiac CTA evaluation search pattern, a useful guide for clinicians in assessing cardiac CTAs in infants and newborns. Since pediatric patients often present with multiple findings and complex anatomy, this discussion is broken down among the major structures of the cardiovascular system, with extensive imaging examples of situs anomalies, common lung and airway abnormalities, and findings involving the atria, ventricles, outflow tracts, great vessels, and coronary arteries. *The Atlas of Pediatric Cardiac CTA* is a valuable resource for radiologists, cardiologists, and other clinicians involved in the care of pediatric patients with congenital heart disease.

The following people have contributed to the details and understanding of these cases over the past several years during weekly conferences and individual discussions: Ernerio Alboliras, MD; Steve Pophal, MD; John Nigro, MD; David Cleveland, MD; Karim Diab, MD; Ed Rhee, MD; Lourdes Guerrero, MD; David Frakes, PhD; Fariha Ejaz; and Olga Kalinkin MD; Robert Puntel, MD; Christopher Derby, MD; Shabib Alhadheri, MD; Jeane Zenge, MD; Lawrence Lilien MD.

Phoenix, AZ — Randy Ray Richardson, MD

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Advantages of Cardiac CTA over Other Imaging Modalities

1

Randy Ray Richardson and Ernerio T. Alboliras

Congenital heart imaging has changed dramatically over the past several decades. In previous decades, plain x-ray films were a key diagnostic test, with the use of angiocardiography to make specific preoperative diagnoses. However, with several robust cross-sectional imaging modalities now available, this method no longer is the standard. Although plain films still are often obtained, they serve as more of a screening tool, with the first line of imaging being echocardiography. Echocardiography typically does not require sedation and does not expose the patient to ionizing radiation. Echocardiography provides detailed intracardiac anatomy with real-time functional evaluation; however, it may be limited for evaluating extracardiac structure. Similarly, cardiac MRI does not expose the patient to ionizing radiation and offers some of the best tools for functional evaluation of the heart. Cardiac CT angiography (CTA) is another cross-sectional imaging modality that may be used for anatomic and functional evaluation in patients with congenital heart disease. Cardiac CTA does require ionizing radiation; however, with new techniques designed to minimize the patient's exposure, the radiation can be kept within safe parameters and the advantages of CT may be used.

The advantages of cardiac CTA include the following:

1. Cardiac CTA produces the highest spatial resolution images of all three cross-sectional imaging modalities, which is an advantage for the following reasons:
   (a) In infants, CTA offers the best chance to visualize the coronary arteries, aortopulmonary collaterals, and pulmonary arteries. These vessels may be as small as 1–2 mm in diameter.
   (b) High–spatial resolution images allow the best postprocessing of anatomic detail for three-dimensional reconstructions, which often is important in patients with complex congenital heart disease, in whom anatomic relationships help in presurgical planning.
   (c) CTA gives the most accurate volumetric analysis of the ventricles, which may help determine the viability of a two-ventricle repair in a patient with a hypoplastic ventricle.
2. It is the modality of choice for evaluating coronary artery anomalies in infants.
   (a) Coronary artery anomalies are associated with congenital heart disease and may be important for presurgical planning. Even with the very rapid heart rate of an infant, a cardiac CT scan can reliably demonstrate the coronary arteries.

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(b) Although other cross-sectional modalities often allow identification of the origins of the coronary arteries, cardiac CTA affords a more reliable evaluation of the course and termination of the coronary arteries.

3. It provides the best evaluation of the airway. Airway abnormalities frequently cause significant postoperative morbidity in congenital heart patients.
   (a) Congential airway anomalies are common in patients with congenital heart disease.
   (b) Airway compression from vascular anomalies, enlarged vessels (pulmonary arteries, patent ductus arteriosus, aorta), and cardiomegaly are common.
   (c) Bronchomalacia is a common finding in patients with congenital heart disease.
4. Cardiac CT requires short anesthesia times, and a typical scan takes seconds to perform. Short anesthesia times are an advantage in the complex congenital heart patient, in whom anesthesia management may be very difficult for long periods of time outside the intensive care unit. A typical cardiac CTA takes 4–5 s of scanning time. Anesthesia is needed to optimize the scan, with a breathhold required to stop all chest movement.