Preface

This book is designed to offer an updated, comprehensive, and didactic approach to the study of coronary artery anatomy. Coronary anatomy is a highly variable entity. Use of a comprehensive approach is essential for understanding the complexity of this subject, formulating an all-inclusive nosologic scheme, and encompassing the many elements that may be relevant to a detailed study.

An illuminating introduction to coronary anatomy is provided in Chapters 1 and 2 by María V. de la Cruz and coauthors, from the Department of Developmental Biology of the Hospital Infantil in Mexico City and the Texas Heart Institute in Houston. In reviewing the coronary anatomy of different chordates (Chapter 1), these authors point out the critical intrinsic relationship between coronary artery morphology and the evolving anatomy of the myocardial walls (essentially ventricular) and of the respiratory system typology.

Chapter 2 gives an updated description of the critical embryologic stages in the development of the coronary arteries: the precoronary (intertrabecular), the ventriculo-venous, and the end-developmental stage, featuring coronary arteries that originate from the aorta. This chapter cites recent fundamental contributions by different authors regarding the proepicardial organ, which seems to provide the essential components of the epicardial coronary arteries, as well as the cardiac neural crest. It also hints at the major current challenge of clarifying the origin and morphogenesis of the intramyocardial coronary vessels.

In Chapter 3, Valentín Sans-Coma and other biologists at the University of Málaga (Spain) discuss their original findings obtained from a unique experimental model—a family of hamsters selected by means of inbreeding techniques in order to express a high incidence of both anomalous coronary arteries and bicuspid aortic valve. The authors' findings point to the existence of one or more genetic factors that regulate the development of truncal septation and coronary origination from the aortic sinuses, probably by influencing the development of the cardiac neural crest.

Chapter 4 addresses the primary objective of this book by discussing human coronary anomalies in a rational, organized manner. This chapter is based on the experience of the Department of Cardiology at the Texas Heart Institute. The chapter's basic methodology depends on a feature-by-feature description of morphologically normal coronary arteries; once "normality" has been thus defined, coronary anomalies are described as exceptions to the norm. Because normality is hard to define with respect to such a highly variable subject as the anatomy of the coronary arteries, the literature contains no universal definitions of normality. We propose that "normal" be defined as "what is observed in more than 1% of the population" and that this definition be used prospectively to identify coronary anomalies in an otherwise normal population. In the interests of practicality, technical adequacy of description, and clinical relevance, we report the incidence of the different anomalies not on the basis of traditional anatomic descriptions but, rather, on the basis of a prospective analysis of selective coronary angiograms, using the foregoing proposed definition of normality. In attempting to define the essence of each coronary anomaly, this chapter stresses the conceptual approach; however, it also includes an extensive angiographic gallery, which presents examples of most coronary anomalies, along with angiograms and clinical-functional correlations. To provide the latest available information about pathophysiology and clinical relevance, the final section of Chapter 4 discusses all proposed (proven and unproven) pathophysiologic mechanisms and clinical manifestations of coronary anomalies, classifying each anomaly by these parameters.

Whereas coronary anomalies can be surprise findings at angiography (usually when performed in adults for an unrelated clinical reason), they may also produce major clinical manifestations, especially in pediatric patients. In Chapter 5, Thomas Fagan and Michael Nihill, pediatric cardiologists at Baylor College of Medicine and Texas Children's Hospital in Houston, provide a specific clinical discussion that focuses on anomalous origination of the left coronary artery from the pulmonary artery and large coronary fistulas in pediatric patients. In that same chapter, Alexis Palacios-Macedo, Charles Fraser, and Denton Cooley, cardiovascular surgeons at the Texas Heart Institute and Texas Children's Hospital, cover the surgical treatment of these coronary anomalies.

In Chapter 6, Dr. de la Cruz and I summarize the current knowledge about the anatomy of the coronary arteries in certain congenital heart defects that we consider particularly relevant. Interest in this subject is generally stimulated by the following issues: (1) Some congenital heart defects involve abnormal development of the cardiac structures that provide the basic framework for the coronary arteries, that is, the

aortic sinuses and left ventricular myocardial mass. It is not surprising that an alteration in the basic framework (congenital heart defect) would lead to an alteration in the morphogenesis of the coronary circulation. Such defects can be viewed as naturally occurring experiments, which could potentially clarify our understanding of normal or abnormal coronary morphogenesis. (2) The surgical approach to some congenital heart defects may be substantially altered by the presence of specific coronary artery patterns (e.g., tetralogy of Fallot, transposition of the great vessels, or pulmonary atresia with an intact ventricular septum).

In Chapter 7, James T. Willerson, Medical Director of the Texas Heart Institute, rounds out the book by presenting some remarks on current and future research into coronary artery anomalies of form and/or function.

This book is being offered to a disparate readership in hopes of stimulating further study and discussion of a complex, poorly organized subject. The recognition, treatment, and prevention of coronary anomalies should be an interdisciplinary effort on the part of primary care physicians, cardiologists, cardiovascular surgeons, public health officials, and specialists in basic biology, among others.

In preparing this book, I have drawn on my 28-year experience at the Texas Heart Institute, the largest cardiovascular center in the world, where thousands of individuals are referred for evaluation and treatment each year. Here, interest in coronary anomalies was initially stimulated by Denton A. Cooley and Grady Hallman, who pioneered numerous operations for correcting congenital disorders in pediatric patients. My own interest in normal and abnormal coronary anatomy was inspired by my proximity to these great surgeons and by the large number of unique coronary variants encountered. These cases aroused intense interest and underlined the need for a more comprehensive approach that could better elucidate the individual nature of a given case.

I wish to acknowledge the kind collaboration of my many cardiology colleagues at the Texas Heart Institute, especially Drs. Bruce E. Barnum, Jaime Benrey, Robert J. Card, Patrick J. Cook, Wayne E. Dear, Carlos M. de Castro, Jr., Sayed Feghali, R. David Fish, Jorge A. Garcia-Gregory, Jorge F. Guttin, Robert J. Hall, Patrick J. Hogan, Zvonimir Krajcer, D. Richard Leachman, Robert D. Leachman (now deceased), Louis Leatherman, Roberto Lufschanowski, Edward K. Massin, Ali Massumi, Virendra S. Mathur, Emerson C. Perin, Donald G. Rochelle, Michele Sartori, Mark J. Schnee, Arthur J. Springer, Eleftherios S. Stamatiou, Neil E. Strickman, Bernardo Treistman, Donald Trillos, Susan Wilansky, James T. Willerson, and Antoine G. Younis, as well as the hundreds of cardiology fellows who have trained at the Institute during the last 28 years. These individuals provided the main source, support, and first audience for the material presented herein.

In addition, I am grateful to the Texas Heart Institute's Section of Scientific Publications for its assistance in the preparation of this book. Specifically, I thank Virginia D. Fairchild for managing and editing this project; Dikombi Gite for typing the manuscript; Christina Chambers for editorial assistance; and Ken Hoge and Melissa J. Mayo for helping with the photographs and illustrations.

Paolo Angelini, M.D.