

Paul A. Iaizzo
Richard W. Bianco
Alexander J. Hill
James D. St. Louis *Editors*

Heart Valves

From Design to Clinical Implantation

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Preface

Cardiovascular disease is the major cause of morbidity and mortality worldwide. While the past 40 years have brought major progress in cardiac valve repair and replacement, there remain large patient populations that do not receive such therapies. This, in turn, implies a great need for future basic, applied, and clinical research and, ultimately, therapeutic developments.

Even with major medical advances, everyday in the United States alone, thousands of patients die due to underlying valve pathologies. In this disease category, aortic valve replacement is the most common intervention, which was first performed in the 1970s. To understand complex causes of valvular diseases in varied populations, the underlying mechanisms, and/or optimal therapies, the scientific and medical communities face tremendous challenges, and this will require great effort and cooperation. In other words, there is currently a major need to continue to develop new and better therapies for treating such patients. Accordingly—and fortunately—an ever increasing number of medical device developers and medical personnel are interested in studying various aspects of valve failure and valve repair/replacement at basic, translational, and applied levels. Recently, there has been a major push towards developing minimally invasive valve repair or replacement procedures; although this is exciting and could increase therapy for broader patient populations, there remains much research to be performed. Not only has our overall understanding of the molecular basis of disease dramatically increased, but we are also seeing a growing number of available and emerging molecular, pharmacological, and device treatment-based therapies.

We recognize that there is a need, albeit one that poses a great challenge, to provide guidance for researchers in this field, in the form of a practical, state-of-the-art handbook dedicated to (1) cardiac valve anatomy, (2) models for testing and research methods, (3) clinical trials, and (4) clinical needs and applications. As such, one of our primary goals is to showcase the various authors' expertise on these topics and provide readers with a single resource. It should also be noted that this textbook has been primarily written by scientists and clinicians from leading academic and industrial institutions around the world, whose work has had a major impact on the field of cardiac valve repair and/or replacement.

We hope that this textbook with a focus on heart valves will be a helpful reference for patients, educators, students, device designers/developers, clinical study specialists, clinicians, and other associated healthcare providers. We are grateful to all authors for their excellent contributions, to Monica Mahre for her outstanding administrative support, and to Springer publishers for making this book a reality.

Twin Cities of Saint Paul and Minneapolis, Minnesota, USA

Minneapolis, MN, USA

Mounds View, MN, USA/Minneapolis, MN, USA

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Part I
Anatomy, Physiology,
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Chapter 1

The Anatomy and Function of the Atrioventricular Valves

Michael G. Bateman, Jason L. Quill, Alexander J. Hill, and Paul A. Iaizzo

Abbreviations

APM Anterior papillary muscle complex (superoposterior)
PPM Posterior papillary muscle complex (inferoanterior)

1.1 Introduction

Since the second and third century BC, when Galen used dissections of animals to improve his understanding of human anatomy, great physicians and anatomists such as Vesalius, Leonardo da Vinci, Hunter, and Gray completed postmortem examinations on both humans and animals to investigate the frailties of the human body. Their work was often recreated in elegant treatises such as the collection presented

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