

## Computer Simulation and Experimental Assessment of Cardiac Electrophysiology

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This book analyzes the use of computer and modeling techniques, both for the analysis of experimental and clinical data and for the simulation of diverse aspects of cardiac electrophysiology and mechanics as well as the application and development of therapeutic options for treating cardiac arrhythmia. The book is divided into 6 sections, each consisting of several chapters (between 2 and 5 per section) and ends with a brief discussion of the usefulness of computer simulations in the development of new therapeutic strategies. The book consists of 191 pages with each chapter averaging 9 pages, and includes numerous figures (72 total) which clearly illustrate the text. Each chapter contains a well-edited bibliography which facilitates further research of the topics covered. From the technical point of view, the book is well-edited, the print and illustrations are high quality, the format is small (quartile-size pages), and the writing is not too complicated (in spite of the specialized nature of the topics being discussed), due to its format of brief chapters that primarily review the available information for each topic.

The first 2 sections are dedicated to the mapping of atrial (Section I) and ventricular (Section II) electrical activity, as well as computer simulation of arrhythmias in cardiac activation models. The authors are researchers who have used these tools in their research, and they clearly explain their most relevant applications. In Chapter 1, they review the results of principal studies of atrial electrical activity mapped in patients during atrial fibrillation (AF), and Chapter 2 the role of the deterioration of interatrial conduction in the initiation of arrhythmia. Chapter 3 describes computer simulations of arrhythmias in human atria based on the kinetics of the ionic transmembrane currents, developed to improve knowledge of the arrhythmias and the initiation and perpetuations mechanisms of same, such as the importance of anatomical obstacles, geometry of the atria, anisotropic conduction, or heterogeneity in repolarization. Chapter 4 discusses the viability of a model of spread of electrical activation in atrial tissue, and Chapter 5 is

dedicated to the analysis of the usefulness of non-invasive electrocardiography images for detecting and reconstructing abnormal electrophysiological substrates in a myocardial infarction and for visualizing activation sequences during cardiac arrhythmias. Chapter 6 emphasizes the significance of frequency gradients observed in various experimental ventricular fibrillation (VF) models and highlights the experimental data from various studies supporting the hypothesis that VF originates from sources of high frequency activation with fibrillatory conduction to the rest of the myocardium. Chapter 7 analyzes the process of ventricular excitation via simulation of the activation sequences, changes in potential, and the creation of electrograms which register them, and Chapter 8 deals with 3-dimensional aspects of the re-entry process during VF. The last chapter of Section II, Chapter 9, analyzes alternance during action potentials and their modification by early extra systoles in a monocellular model.

Section III of the books is dedicated to analyzing models of mechanical cardiac activity and consists of 2 chapters: Chapter 10, which describes the measurement of local mechanical activity by magnetic resonance imaging, which provides information on local structural changes and the initiation of contractions, and Chapter 11 explains experimental models and computer simulation of electromechanical interactions, especially in electrical feedback and its contribution to causing arrhythmias.

Section IV discusses global heart modeling and consists of 3 chapters: Chapter 12 is on electrophysiology and electrocardiography encompassing anatomical models, conduction and propagation, applicable to both diagnostics and teaching. Chapter 13 deals with 3-dimensional modeling of human atria to simulate, on a large scale, normal and pathologic activation, exploring the relationship between membrane changes, electrophysiological changes in tissue, and atrial geometry as related to atrial arrhythmias. Chapter 14 presents the model developed in Auckland of cardiac

metabolism, electrophysiology, and mechanics, including anatomical and cellular electrophysiology, and the propagation process of cardiac electrical activity and the mechanics of both muscles and the ventricles.

Section V is dedicated to various therapeutic options related to AF and consists of 3 chapters. In Chapter 15 the mechanisms of atrial fibrillation are described, the most salient investigative studies on the subject are highlighted, and the controversy whether AF is indeed due to re-entry or to fibrillatory conduction with a focus on rapid activity, and also reviews the experimental models used and the information provided by mapping techniques. Chapter 16 discusses a computer model for studying the effects of therapeutic interventions based on radiofrequency ablation that simulates the effects of AF, and Chapter 17 is dedicated to the clinical aspects of atrial fibrillation.

Section VI centers on analyzing the therapeutic options used to interrupt ventricular fibrillation and consists of 3 chapters. Chapter 18 analyzes the mechanisms of ventricular defibrillation by electric shock, and describes the effects of the shock intensity on myocardial response and on activation patterns

upon shock application, in successful and unsuccessful cases. Chapter 19 describes the role of virtual electrodes in re-entrance induction and in defibrillation; as the authors show, for defibrillation to be effective the shock must extinguish the existing activation fronts and must not induce new re-entry activations. This chapter broaches the hypothesis of the virtual electrode, a subject which is also developed in Chapter 20.

Finally, section VII is dedicated to a discussion of the usefulness of computer mediated simulations in developing new therapeutic strategies for treatment of arrhythmias. In this chapter the authors comment on the role of integrating basic investigation, experimentation, and computer simulation in the developing new therapeutic, pharmacologic, electrical, and surgical options.

In summary, this is a book which explores, in a concise and clear manner, various aspects of using analysis and computer models in the field of electrophysiology and cardiac mechanics. The book serves as a guide for future research and allows us to navigate, without difficulty, the studies related on these subjects with the object of increasing and deepening our understanding of these topics.

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