A Complete Guide to Atrial Abnormalities

From Computational Analysis to Clinical Applications

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Edited by

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Preface

The heart's atria, often overshadowed by their bigger and more muscular counterpart, the ventricles, play a crucial but frequently overlooked role in cardiac function, rhythm, and overall cardiovascular health. Understanding the complexities of atrial abnormalities is essential for clinicians and researchers aiming to improve patient outcomes and delve deeper into the heart's intricate workings. This book, *A Complete Guide to Atrial Abnormalities, From Computational Analysis to Clinical Applications*, provides a comprehensive exploration of normal atrial anatomy and physiology and the various conditions affecting the atria, from their structural and pathophysiologic nuances to advanced diagnostic and therapeutic approaches.

The chapters within this volume are organized to cover foundational and cutting-edge knowledge. We begin with an in-depth examination of atrial anatomy and electrophysiology, to provide the reader with a robust understanding of the atria's architectural, histological, and electrophysiological characteristics. This knowledge is needed as a foundation to understand the chapters that address different illness situations, particularly to understand diagnostic criteria and classifications, as in the case of the different types of interatrial blocks, a disorder often encountered but not fully appreciated in clinical practice.

Atrial dyssynchrony is a quite new concept and we explore the causes and consequences of this often-overlooked condition, while later chapters, such as those on atrial fibrillation and atrial flutter, detail the epidemiology and clinical implications of the most prevalent atrial arrhythmias, which continue to challenge clinicians globally. Bayés syndrome, characterized by the presence of advanced interatrial block coupled with atrial arrhythmias, is explored in detail, highlighting its association with increased risks of stroke, dementia, and mortality.

The guide further addresses atrial enlargement, emphasizing its role as a marker of prolonged elevated atrial pressure and its ties to different conditions that might be simultaneously present or not, as interatrial block, diastolic dysfunction, left ventricular hypertrophy, and valvular heart disease. The previous atrial abnormalities are now included in the broad concept of atrial failure, a global clinical entity representing any atrial dysfunction leading to impaired cardiac performance that is presented comprehensively.

In the era of personalized medicine, understanding the molecular underpinnings of atrial function and remodeling is paramount. This book offers a thorough review of the implications of precision medicine in all atrial abnormalities, emphasizing the role of fibro- and thrombo-inflammatory biomarkers in improving diagnosis, treatment, and prevention.

The focus in atrial involvement in different heart diseases is remarkably important, showcasing the role of advanced imaging techniques in assessing atrial structure and function across various conditions. We finish peering into the future, discussing the transformative potential of artificial intelligence and computational analysis in the study of atrial conditions. Machine learning and deep learning models promise to refine our understanding and offer novel avenues for diagnosis, treatment, and predictive analytics in atrial health and disease.

In our opinion, this guide is a must-read for cardiologists, electrophysiologists, and all clinicians and researchers who wish to expand their knowledge of atrial abnormalities and apply this understanding to enhance patient care. A tremendous effort has been made by well-known experts and pioneers in the identification of atrial abnormalities to bring together the latest research, diagnostic tools, and treatment strategies, ensuring a holistic perspective on this crucial aspect of cardiovascular medicine. With this book in hand, readers will be equipped to address the challenges posed by atrial conditions with a newfound depth of knowledge and precision.

Manuel Martínez-Sellés

CHAPTER

1

Atrial anatomy and electrophysiology

Tomas Datino[1], Adolfo Fontenla[1], Damian Sánchez-Quintana[2], Nina Soto Flores[1], David González Casal[1], Jorge González-Panizo[1] and Jose Angel Cabrera[1]

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Abbreviations

AF	atrial fibrillation
AP	action potential
AVN	auriculoventricular node
CTI	cavotricuspid isthmus
LA	left atrium
LAA	left atrial appendage
RA	right atrium

The atria, as integral components of the human heart, not only function as reservoirs for venous return but also are dynamic components of the cardiac conduction system. The knowledge of the anatomy, histology, and function of the atria has been taking more and more importance in modern cardiology, both to properly perform cardiac imaging tests and to be able to carry out invasive cardiology procedures with precision. Their positioning, structural adaptations, and spatial relationships with neighboring organs and structures underscore their significance in interventional cardiology and cardiac surgery. The atria, like the rest of the heart, are located in the middle mediastinum, surrounded by the pericardium (Fig. 1.1).

The right atrium (RA) receives deoxygenated blood from the systemic circulation and is situated anterior and inferior to the left atrium (LA) and superior and posterior to the right ventricle. It is bordered superiorly by the superior vena cava and inferiorly by the inferior vena cava. Additionally, the coronary sinus, which collects blood from the cardiac veins, opens into its posterior wall. The RA maintains anatomical relationships with multiple adjacent structures, among which the aorta is one of the most significant. The right atrial appendage is oriented leftward and lies over the aortic root, while the anterosuperior portion of the interatrial septum covers the non-coronary sinus of the aorta (Figs. 1.2 and 1.3). Anteriorly, the RA is in proximity to the anterior mediastinal aspect of the right

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lung, from which it is separated by the pleura and pericardium. Additionally, the right superior pulmonary vein passes posterior to the superior cavoatrial junction, whereas the right inferior pulmonary vein traverses just behind the intercaval area.

The LA, in contrast, serves as the receiving chamber for oxygenated blood returning from the lungs via the pulmonary veins. Its posterior location within the mediastinum provides a unique set of anatomical relationships. Positioned directly anterior to the esophagus and the descending thoracic aorta, the LA is a critical structure in both normal physiology and pathological states.

The pericardial sac creates a set of anatomical spaces known as pericardial recesses, which are clinically significant landmarks for imaging and interventions (Figs. 1.1–1.4). Two notable recesses, the transverse pericardial sinus and the oblique pericardial sinus, are closely associated with the atria. The transverse sinus is located posterior to the ascending aorta and pulmonary trunk, anterior to the superior vena cava, and superior to the LA. The oblique sinus, on the other hand, is a cul-de-sac posterior to the LA, bordered by the pulmonary veins and inferior vena cava. In this zone, the posterior wall of the LA is at a distance of less than 5 mm from the wall of the esophagus. This relationship is very important in clinical practice. On the one hand, it is the typical access of the transesophageal echocardiogram. On the other hand, in ablation procedures of the posterior wall of the LA, the esophagus can be injured.

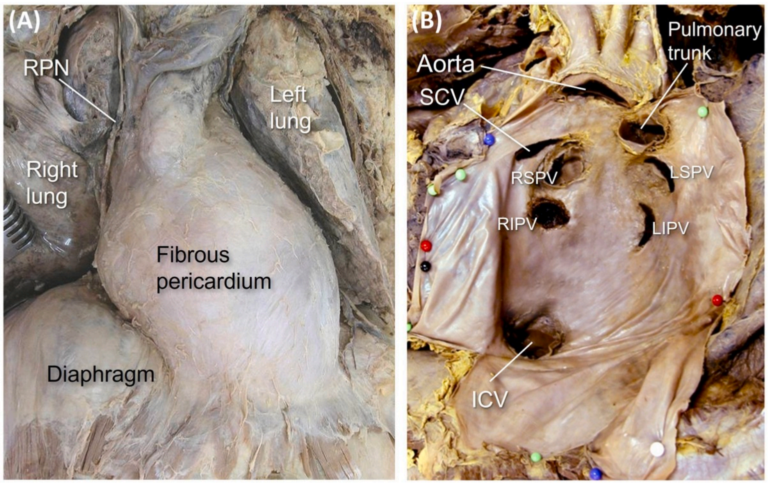

FIGURE 1.1

The heart and the pericardial space. (A) Frontal view of the mediastinum of the chest showing cardiac margins. Note the fibrous pericardium inserting into the diaphragm and the right phrenic nerve (RPN) close to the superior caval vein. (B) This dissection of a cadaver viewed from the front shows the transverse and oblique sinuses following the removal of the heart. *ICV*, Inferior caval vein; *LIPV and LSPV*, left inferior and superior pulmonary veins; *PT*, pulmonary trunk; *RIPV and RSPV*, right inferior and superior pulmonary veins; *SCV*, superior caval vein.

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