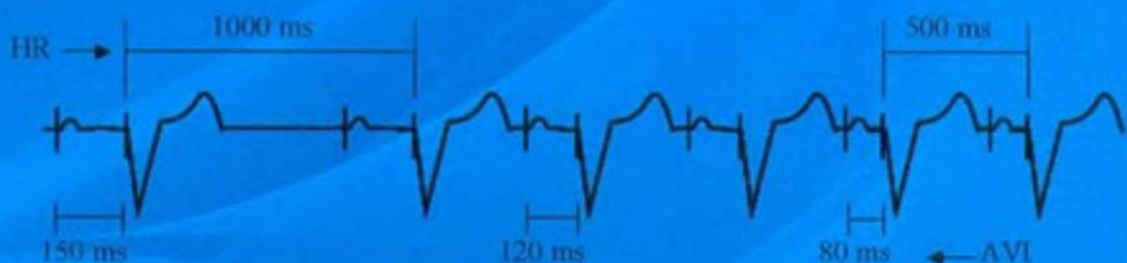


编著 蔡伯林

起搏器

心电图图谱

Pacemaker ECG and Atlas



人民军医出版社

PEOPLE'S MILITARY MEDICAL PRESS

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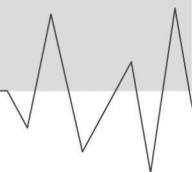
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内容提要



本书以图谱形式，从起搏器原理讲起，介绍了起搏器心电图方面的知识。全书共 15 章，内容包括起搏类型、起搏指征、起搏模式、起搏器系统与硬件、起搏器心电图及其心电图诠释等。全书为中英文对照，重点讲解了起搏器心电图的分析和判断，书末附有起搏器心电图练习，层次清晰、语言简洁，适于临床心血管医师、研究生、心电图专业人员参考阅读。



前言

起搏器应用国内亦日甚广泛，故，起搏器心电学知识务为专业人员之重要的从业基础。起搏器安装易，认识功能障碍善后难，精通起搏器心电生理更难。临床猝于起搏者每每发生，诸见于术后，而非术中。若能精通识别异常起搏之心电图并能正确处置，方能得心应手。所谓精通，非广读深研不可就，加之现成读本乏陈可据，相关资料多见外文书刊，为此，本书英中相并，可望助益。

临床医生仅是起搏器使用者，设计制造乃属电生物物理工程师们，但要分析起搏心电图，使用者亦不得不对基本原理有所理解，其中起搏时相周期最为要领。工程师们之原著理论多沉长，往往一图描述数页，仍难得其要，令人倦怠，倒不如看图识字更能一目了然。故本书以图解为主，释以文字，力求明了。最后附以图例分析，以达实践之目的。

起搏器日趋新型，功能更形复杂，可基本原理不变，学以基础，即能举一反三，反复实践，必然长进。

此书非寻常厚著，也未面面俱到，深入浅出不承，误论必有之，祈唯鉴不吝。

哥伦比亚大学医学院心脏学医师，詹孔明 (Kong-Ming Jan) 教授繁忙中校阅此书，并作重要修改，在此诚挚顿首。

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FOREWORD



Selection of pacemaker mode and proper interpretations of pacemaker electrocardiogram (ECG) are very important and essential in medical practice. A short practical and yet comprehensive book with basic electrophysiological principles, pacemaker design, and interpretation of pacemaker ECG are urgently needed.

Dr. Bolin Cai came to Columbia University Medical Center and began his research in cardiology in 1991. Besides doing research, he has accumulated an extensive experience in Holter monitor scanning and interpretation. Dr. Cai wrote this book “Electrophysiology and Interpretation of Pacemaker ECG”, dedicated not only to people who wish to learn or review quickly the basics of pacemaker ECG, but also to people who wish to acquire the ability to interpret the complex strips of pacemaker ECG. The latter is further aided by providing the exercise sessions of sample interpretations to the readers. Furthermore, the book emphasizes the simplicity rather than the complexity of pacemaker ECG. This is achieved by giving the readers only those essential concepts that are needed to make interpretations.

This book allows health care professionals including physicians, nurses, physician assistants, and paramedics, who are interested in learning basics and interpretations of pacemaker ECG including its normal and abnormal functions. Readers are expected to grasp the necessary skills to become a proficient interpreter of pacemaker ECG.

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Chapter 1 Basic Principles of Pacing

第 1 章 起搏基本原理

The aim of this chapter is to give sufficient background and information about cardiac pacemakers to allow interpretation of ECGs and telemetry strips of normal pacemaker behavior; to understand the indications and utility of a cardiac pacemaker; to be familiar with the coding system by which pacemaker modes are determined; to know what a paced ECG looks like and to be familiar with the different types of emergency pacing.

本章旨在描述起搏器基本知识，以便解释起搏心电图、远程心电图，了解起搏器的应用与适应证，熟悉起搏器编码系统及其起搏模式，认识各种包括紧急起搏的起搏器心电图。

一、What's the pacemaker

什么是起搏器

A pacemaker refers a medical artificial device which delivers electrical impulses through electrodes to stimulate the heart in order to regulate its rate and rhythm. It is primarily used to treat severe bradycardia resulted from abnormal sinoatrial node function or impaired or absent conduction through the atrioventricular node. Modern artificial pacemakers are programmable externally and selectable modes for the individual patient. A pacemaker and defibrillator can be assembled together in a single implantable device for both pacing and defibrillation. Some employ multiple electrodes to stimulate different positions in the heart to improve synchronization of the cardiac chambers.

何谓起搏器？即是一种人工医学装置，通过电极释放脉冲刺激心脏以调节心率和节律。主要用来治疗因窦房结和房室结功能异常所致的严重心动过缓。当代起搏器可为每个病人做体外程序设计和选择起搏模式。起搏器和除颤器可组装一起，既可起搏又可除颤。有些



且用多电极刺激心脏不同部位以达心脏同步功能。

二、What are the working principles of a pacemaker 何为起搏器做功原理

It is a process that a pacemaker delivers stimulus to depolarize a chamber or inhibits stimulation according to the indications controlled by its sensor. A single chamber pacemaker may deliver stimulation in a fixed rate. While, a pacing chamber, sensor sensing and pacing response constitute the working principle of a dual chamber pacemaker.

这是一个全过程，即起搏器根据其感知器指令释放刺激除极心腔，或抑制刺激。单腔起搏器可能按固定频率释放刺激，而双腔起搏器的做功原理由起搏心腔、感知器感知，以及起搏应答所组成。

1. Pacing chambers 起搏腔室

Where does a pacemaker pace? A pacemaker may pace either atrium or ventricle, or both. If a pacemaker paces only one chamber, it is called single chamber pacing, which is asynchronous pacing. If a pacemaker paces both the atrium and ventricle sequentially, it is considered dual-chamber pacing. It is AV synchronous pacing that has physiologically superior as the atrial contraction is restored.

起搏器起搏何部位？可起搏心房、心室，或同时二者。若只起搏一心腔，谓之单腔起搏，此系非同步起搏。若顺序起搏心房与心室，谓之双腔起搏，系同步起搏，因还原心房收缩，故甚具生理性。

2. Sensor sensing 感知器感知

How can a pacemaker know when the heart needs pacing? A sensor in a pacemaker is able to sense an intrinsic cardiac activity and respond suitably, either resulting in pacing or withhold in synchrony with the intrinsic heart rhythm.

起搏器何知需要起搏？感知器能感知心脏固有活动，做出起搏或者保持与固有心律同步的恰当反应。

3. Pacing response 起搏回应

How does a pacemaker have response to the sensing? Basically, a pacemaker responds to sensing in two ways by which it initiates impulses.

起搏器对感知如何回应？基本上，起搏器对感知以两种方式产生脉冲反应。

(1) Triggering, a pacemaker paces whenever an intrinsic or paced activity is sensed. This is most commonly seen in a dual chamber pacing, in which the sensing of a sinus or paced P wave triggers the ventricular lead to pace.

触发反应，只要一自然或者起搏活动被感知，起搏器便起搏。触发最常见于双腔起搏，



当一窦性或者一起搏 P 波被感知时，便触发心室起搏。

(2) Inhibition, a pacemaker is inhibited to deliver pacing stimulus whenever an intrinsic beat is sensed by the sensor. Inhibition is seen in both single and dual chamber pacemakers.

抑制反应，只要一自然搏动被感知，起搏器便停止起搏。此既见于单腔，也见于双腔起搏器。

三、Conduction anatomy 传导系统解剖

To understand the principles and concepts involved in cardiac pacing more thoroughly, a brief review of the anatomy and physiology of the specialized conduction system is necessary. An electrical impulse generated in the sinoatrial (SA) node depolarizes the atria to contract. The impulse then congregates upon the atrioventricular (AV) node with a short period of delay and continues spreading of the bundle branches and Purkinje's fibers to depolarize the ventricles (Figure 1-1). The SA node, AV node and the His-Purkinje system are involved as the relevant anatomy for cardiac pacing. A single chamber pacemaker of atrium or ventricle can actually be considered to replace the SA or AV node respectively. While the AV sequential pacing, or dual chamber pacemaker, is likely to be an AV bridge for the conduction.

以便较能透彻理解起搏原理，有必要复习传导系统之解剖生理功能。缘于窦房结之脉冲除极心房使之收缩，然后冲动沿房室结下传并稍延搁，经束支、His 束及浦肯野纤维除极心室（图 1-1）。窦房结、房室结、His-浦肯野系统诚然参与心脏起搏全过程。心房或心室单腔起搏器，实可认作窦房结或房室结之替代；而房室顺序起搏，或双腔起搏器，犹承房室桥梁之功能。

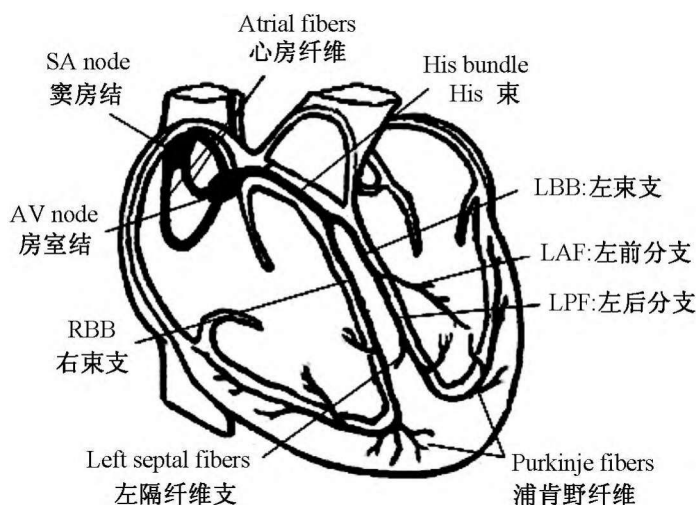


Figure 1-1 Anatomy of the heart conduction system

图 1-1 心脏传导系统解剖

Chapter 2 Pacing Type

第 2 章 起搏类型

Pacemakers can be described for their different types according to the duration of pacing, the chamber paced, the chamber sensed, and the response of the pacemaker to the sensed impulse as well as polarities. Some of the more common types of pacemakers are listed here.

根据起搏持续时间、起搏和感知腔室，以及对感知事件和极性的反应，起搏器可分不同类型。现列举常见类型。

一、Temporary pacing

临时起搏

Temporary pacing can be performed as transcutaneous pacing or transvenous pacing. The former is also called external pacing, which is recommended for the initial stabilization of hemodynamically significant bradycardia of all types. The procedure is performed by placing two pacing pads on the patient's chest, either in the anterior/lateral position or the anterior/posterior position. The rescuer selects the pacing rate, and gradually increases the pacing current (in mA) until electrical capture (characterized by a wide QRS complex with a tall, broad T wave on the ECG) is achieved, with a corresponding pulse. An external pacing is an emergency procedure that acts as a bridge until transvenous pacing or other therapies can be applied.

临时起搏可经皮或静脉实施，前者又称体外起搏，用于初步稳定心动过缓时的血流动力学异常。置起搏电极板于患者前/侧或前/后胸壁，确定好起搏频率、递增电压，直至起搏心脏（QRS-T 宽大），并获相应频率。体外起搏系紧急措施，经静脉起搏或者其他有效治疗前起过渡作用。



Alternatively, a transvenous pacing is mostly used by passing a wire through vein to either the right atrium or right ventricle with the other end connecting to the external pacemaker. The transvenous pacing usually functions as a bridge to permanent pacemaker placement or until there is no longer need for a pacemaker.

而经静脉起搏者，导线经静脉抵达心房或心室，另一端连接体外起搏器。此法通常为安装永久起搏器前的桥接作用，或者直到本身不再需要起搏为止。

二、Permanent pacing

永久起搏

Permanent pacing involves transvenous placement of electrodes inside heart chamber. After satisfactory lodged in the heart the opposite end of the electrode lead is connected to the pacemaker generator.

永久起搏需经静脉将电极置于心腔内，一端嵌入心脏，另一端连接起搏发生器。

三、Unipolar pacing

单极性起搏

Pacing stimulus or electric current delivers between the tip of the pacing lead and the shell of the pulse generator (Figure 5-5A). In this mode, the current travels through a large area of the body between the tip of the lead and the pulse generator, therefore, creating a large stimulus artifact on the surface ECG (Figure 10-1A). It may stimulate electrically excitable tissue, other than the heart, which lies in the path of the current. An example of such a tissue would be the pectoralis muscle over which the pacemaker generator is placed.

起搏器于起搏导线顶端与脉冲发生器外壳之间释放电流（图 5-5A），因电流大面积地通过机体，故在体表心电图上出现很大的起搏信号（图 10-1A），脉冲可能刺激位于电流通道内的兴奋性组织，比如起搏器埋藏处的胸壁肌肉，而非心脏本身。

四、Bipolar pacing

双极性起搏

Pacing stimulus or electric current delivers between the tip and the ring electrodes of a bipolar pacing lead (Figure 5-5B). The pacing artifact of this mode may be very difficult to see on the surface ECG, because the distance between the tip and the ring of the lead that delivers the current