

Contents

Foreword	xiii
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Michael H. Crawford

Preface	xv
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Mario J. Garcia

Cardiac CT: Understanding and Adopting a New Diagnostic Modality	555
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Mario J. Garcia

For many years, the holy grail in cardiac imaging was the noninvasive anatomic evaluation of the coronary arteries. Although functional tests allow for the detection of ischemia, they lack sufficient sensitivity and specificity to reliably exclude obstructive coronary artery disease in many symptomatic patients, and have practically no role in establishing the presence of non-obstructive disease in asymptomatic subjects who may benefit from preventive interventions. The very short history of cardiac CT has demonstrated rapid technological advances and the potential to eliminate the need for invasive diagnostic testing in patients who have suspected coronary artery disease. This article reviews the history of this modality, the principles and challenges for its clinical implementation, and provides a preamble to this special issue of *Cardiology Clinics*.

Diagnostic Accuracy of CT Coronary Angiography	563
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Divya Kapoor and Randall C. Thompson

There is a rich and rapidly growing literature on the diagnostic utility of coronary CT angiography (CTA) and its performance relative to other modalities such as stress testing and invasive coronary angiography. Earlier studies of 16-slice coronary CTA showed wide variability in sensitivity (30%–95%) and some variability in specificity (86%–98%). With 40- and 64-slice coronary CTA, more of the chest is covered with each spin of the gantry, the breath hold is shorter, and there are fewer uninterpretable segments than with 16-slice coronary CTA. The very high negative predictive value is especially helpful in ruling out coronary artery disease in patients who have low to intermediate pretest likelihood of CAD.

The Prognostic Value of Cardiac Computed Tomographic Angiography	573
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Fay Y. Lin, Suzanne E. Zentko, and James K. Min

With advancements in temporal and spatial resolution, CT has excellent diagnostic characteristics for non-invasive evaluation of coronary artery disease in appropriate patients. Nevertheless, clinical usefulness of diagnostic testing requires not only high diagnostic accuracy but also risk stratification for patient management. Current guidelines for risk stratification of patients with coronary artery disease rely primarily upon functional testing; alternatively, anatomic risk stratification may also be performed with invasive coronary angiography. This article reviews current and emerging concepts in the prognostic value of cardiac CT angiography.

Cardiac CT in the Emergency Department

587

Kavitha M. Chinnaiyan, Gilbert L. Raff, and James A. Goldstein

In the United States alone, nearly 6 million patients present annually to emergency departments with complaints of chest pain suggestive of acute coronary ischemia. Most of these patients have a non-negligible risk for acute coronary syndrome(s) (ACS) and undergo extended observation and workup for an ischemic cause. Of those admitted for extended observation, less than 30% of patients have true ACS. In patients with a low to intermediate probability, cardiac CT performs well in ruling out coronary artery disease, and American College of Cardiology and American Heart Association guidelines deem this application to be “appropriate.” This article reviews the application of CT for the evaluation of acute chest pain the emergency department.

Functional Versus Anatomic Imaging in Patients with Suspected Coronary Artery Disease

597

Leslee J. Shaw and Daniel S. Berman

Patients with suspected or known coronary artery disease often require evaluation by cardiac imaging tests. The purpose of these tests may vary according to each individual patient, from establishing or ruling out obstructive coronary artery disease as the cause of symptoms to determining the risk of future cardiac events and guiding the selection of medical therapy and revascularization. With the adoption of cardiac CT, most patients can have a complete evaluation noninvasively. The challenge is to determine when anatomical evaluation of coronary artery disease or functional evaluation of the burden of ischemia may be required. This article reviews the relative value of anatomical versus functional imaging and their complementary role in different clinical scenarios.

Cardiac CT in Asymptomatic Patients at Risk

605

Paolo Raggi

Atherosclerosis is a systemic process that can develop as early as the second or third decade of life. A significant percentage of patients who experience acute coronary syndromes often have non-obstructive coronary artery disease and thus cannot be diagnosed by their symptoms or conventional functional stress testing. It has been proposed that early detection of atherosclerosis would generate novel opportunities for primary prevention through changes in lifestyle or even through drug therapy, especially in patients at high cardiovascular risk. Calcium scoring is a simple, reproducible, and widely available test that has been extensively validated over the past two decades. In this article, the utility of calcium scoring and the potential application of CT coronary angiography in asymptomatic patients at risk are reviewed.

Evaluation of Coronary Atherosclerotic Plaques

611

Christoph R. Becker and Tobias Saam

In many patients, unheralded myocardial infarction associated with a mortality of approximately 20% is the first manifestation of coronary artery disease. Approximately 40% of the population is considered to have a moderate midterm risk of 10% to 20%. Any of the stratification schemes suffers from a lack of accuracy to correctly determine the risk, and uncertainty exists regarding how to treat individuals who have been identified to be at intermediate risk. Other tools providing information

about the necessity to reassure or to treat these patients are warranted. Currently, the assessment of the atherosclerotic plaque burden by CT may be able provide valid information for this cohort. This article discusses the potential value and limitations of cardiac CT for evaluating coronary atherosclerotic plaque.

CT Applications in Electrophysiology 619

Subodh B. Joshi, Andrew R. Blum, Moussa Mansour, and Suhny Abbara

In recent years, extraordinary advances have been made in the management of cardiac arrhythmias. Increasingly complex procedures are being performed, and the breadth of conditions for which invasive arrhythmia therapy is indicated continues to grow. In addition to atrial and ventricular ablation procedures for treating arrhythmias, implantable defibrillators and biventricular pacemakers for cardiac resynchronization therapy have made electrophysiology an important part of heart failure management.

Evaluation of Cardiac Valves Using Multi-Detector CT 633

Juan Gaztanaga, Gonzalo Pizarro, and Javier Sanz

Cardiac CT is an accurate and reasonable alternative modality for valvular imaging. It is used primarily for the evaluation of coronary artery disease; however, important information regarding valvular anatomy and function can be derived from CT. Calcification is a common CT finding in various valvular abnormalities and carries important diagnostic and prognostic value. In addition, valvular morphology, stenosis, and regurgitation also are detected on contrast enhanced scans, with good correlation with trans-thoracic echocardiography and other techniques.

Left Ventricular Function, Myocardial Perfusion and Viability 645

Yasuyuki Kobayashi, Albert C. Lardo, Yasuo Nakajima, Joao A.C. Lima, and Richard T. George

Cardiac computed tomography is now poised to revolutionize the practice of cardiology. Multi-detector row CT (MDCT) has the potential to evaluate cardiac function, myocardial perfusion, and viability. These capabilities, combined with the robust ability of MDCT to noninvasively image the coronary arteries, makes MDCT a comprehensive tool for the evaluation of coronary artery disease and its anatomic and physiologic impact on the myocardium. Recent technologic advances in MDCT technology in regards to detector coverage, and spatial and temporal resolution promise to improve the capabilities of cardiac CT in the assessment of cardiac function, perfusion, and viability.

Recent Technologic Advances in Multi-Detector Row Cardiac CT 655

Sandra Simon Halliburton

Recent technical advances in multi-detector row CT have resulted in lower radiation dose, improved temporal and spatial resolution, decreased scan time, and improved tissue differentiation. Lower radiation doses have resulted from the use of pre-patient z collimators, the availability of thin-slice axial data acquisition, the increased efficiency of ECG-based tube current modulation, and the implementation of iterative reconstruction algorithms. Faster gantry rotation and the simultaneous use of two x-ray sources have led to improvements in temporal resolution, and gains in spatial resolution have been achieved through application

of the flying x-ray focal-spot technique in the z-direction. Shorter scan times have resulted from the design of detector arrays with increasing numbers of detector rows and through the simultaneous use of two x-ray sources to allow higher helical pitch. Some improvement in tissue differentiation has been achieved with dual energy CT. This article discusses these recent technical advances in detail.

Radiation Dose and Safety in Cardiac Computed Tomography**665**

Thomas C. Gerber, Birgit Kantor, and Cynthia H. McCollough,

As a result of the changes in use of imaging procedures that rely on ionizing radiation, the collective dose has increased by over 700%, and the annual per-capita dose by almost 600% in recent years. It is possible that this growing use may have significant effects on public health. Although uncertainties exist related to the accuracy of estimated radiation exposure and biologic risk, there are measures that can be taken by the referring and the performing health care provider to reduce the potential risks while maintaining diagnostic accuracy. This article reviews the existing data regarding biologic hazards of radiation exposure associated with medical diagnostic testing, the methodologies used to estimate radiation exposure and dose, and the measures that can be taken to effectively reduce that exposure.

Index**679**