HOSPITAL PHYSICIAN®

CARDIOLOGY BOARD REVIEW MANUAL

STATEMENT OF EDITORIAL PURPOSE

The *Hospital Physician Cardiology Board Review Manual* is a peer-reviewed study guide for fellows and practicing physicians preparing for board examinations in cardiology. Each bimonthly manual reviews a topic essential to the current practice of cardiology.

NOTE FROM THE PUBLISHER:
This publication has been developed without involvement of or review by the American Board of Internal Medicine.

Endorsed by the Association for Hospital Medical Education

Myocardial Perfusion Imaging in Coronary Artery Disease

Series Editor:
A. Maziar Zafari, MD, PhD, FACC
Assistant Professor of Medicine, Director, Cardiovascular Training Program, Emory University School of Medicine, Atlanta, GA; Director, Critical Care Unit, Atlanta Veterans Affairs Medical Center, Decatur, GA

Contributors:
Gabriel B. Grossman, MD
Nuclear Cardiologist, Cardionuclear-Instituto de Cardiologia, Fundacão Universitaria de Cardiologia, Porto Alegre, RS, Brazil; Department of Nuclear Medicine, Hospital de Clínicas de Porto Alegre, RS, Brazil

Naomi Alazraki, MD
Professor of Radiology and Co-Director, Nuclear Medicine, Emory University School of Medicine; Chief, Nuclear Medicine, VA Medical Center, Atlanta, GA

Table of Contents

Cover Illustration by mb cunney

next page ↓

Myocardial Perfusion Imaging in Coronary Artery Disease

Gabriel B. Grossman, MD, and Naomi Alazraki, MD

INTRODUCTION

Nuclear cardiology is a well-established field, and its usefulness in clinical decision making for patients with coronary artery disease (CAD) is supported by substantial trial data.[1,2] Single photon emission computed tomography (SPECT) myocardial perfusion imaging (MPI) studies provide important diagnostic and prognostic information for detection of CAD, risk stratification of patients with CAD, and myocardial viability assessment. SPECT MPI can guide decision making in a number of other clinical scenarios (**Table 1**).

The accuracy of SPECT MPI in detecting CAD has been improved by advances in quality control, more effective radiotracers, and new technologies, such as electrocardiogram (ECG)-gated SPECT, relative quantitative analysis, and attenuation correction.[1,2] The further development of molecular imaging is one of the next major steps for nuclear cardiology. New radiotracers for detection of apoptosis, atherosclerosis, unstable plaque, hypoxia, and angiogenesis are being developed. Over the next few years, clinical trials will be conducted to evaluate the appropriate utilization of these radiotracers in patients. This manual discusses the role of SPECT MPI in detection and risk stratification of CAD and in the assessment of myocardial viability and reviews the application of positron emission tomography (PET) in myocardial viability assessment.

MYOCARDIAL PERFUSION IMAGING PROTOCOLS

SPECT MPI is based on the fact that injected radiotracer is distributed in the myocardium in proportion to coronary blood flow. The single gamma photons emitted by the decay of injected radioisotopes are detected by imaging devices known as gamma cameras. These cameras produce planar projection images. Mathematical reconstruction techniques are applied to data sets comprising many planar views taken by the camera over 180 degrees from the right anterior oblique to the left posterior oblique position around the patient's chest (heart) to yield 3-dimensional tracer distribution data, known as SPECT images. These images are viewed as tomographic slices of the left ventricular myocardium in 3 projections (**Figure 1**, *see* page 6).

Technetium-99m (Tc-99m)-labeled tracers and thallium-201 chloride (Tl-201) are widely used with a variety of SPECT protocols to detect CAD.[1,2] Tc-99m-labeled tracers are extracted from the blood by myocytes in proportion to regional coronary blood flow. Uptake of Tc-99m-sestamibi and Tc-99m-tetrofosmin has a linear correlation with blood flow at flow rates up to approximately 2 mL/min/g. Above this rate, uptake decreases and the distribution of Tc-99m tracers plateaus, which results in an underestimation of blood flow (a phenomenon known as "roll-off"). With low flow rates, usually less than 10% of the baseline blood flow, uptake of Tc-99m increases, resulting in an overestimation of coronary blood flow. Uptake of Tl-201 also has a nearly linear correlation with blood flow and plateaus at a higher blood flow rate than Tc-99m (2.5 mL/min/g). Overestimation of coronary flow at low flow rates is also seen with Tl-201.

SPECT MPI with Tl-201 can be used to evaluate ischemia and myocardial viability. A disadvantage of Tl-201 is that the photons it emits upon radioactive decay have lower energy compared with those emitted by Tc-99m (69–81 keV versus 140 keV). Lower photon energy results in more scatter, greater attenuation, and lower quality images, particularly in overweight patients. Tc-99m has higher energy emission than Tl-201 as well as a shorter half-life (6 versus 73 hours), which allows higher millicurie doses to be administered without increasing the patient's radiation exposure. Therefore, many more counts can be obtained with Tc-99m than with Tl-201 in the same amount of time. For this reason, Tc-99m produces higher quality images than Tl-201, and Tc-99m is more suitable for ECG-gating. Dual- isotope protocols (stress with a Tc-99m agent, rest with Tl-201) can be performed in less time than other commonly used