4. Value and limitations of myocardial scintigraphy with thallium-201 and long chain fatty acids for the detection of coronary artery disease

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Introduction

Exercise electrocardiographic stress testing has long been used as the standard noninvasive test for coronary artery disease. Unfortunately, the sensitivity of the test for coronary artery disease is low [1, 2]. The specificity is reduced in patients with ventricular hypertrophy, intraventricular conduction delay, prior myocardial infarction, hyperventilation, ST-T wave changes at rest, electrolyte imbalances, pre-excitation syndromes, and in those taking various drugs such as digitalis and quinidine. Perfusion imaging with thallium-201 after exercise or dipyridamole has been developed in an effort to improve the diagnostic accuracy for coronary artery disease. Myocardial imaging with positron emitting free fatty acids has been used largely as a research tool due to the limited availability of cyclotrons and positron cameras. However, more recently, fatty acids have been labeled with gamma emitting isotopes suitable for gamma camera imaging. This chapter will discuss myocardial imaging with thallium and gamma emitting long chain fatty acids. The chapter will focus on myocardial imaging in patients with known or suspected coronary artery disease.

Myocardial imaging with thallium

Background

The use of thallium-199 as a myocardial perfusion imaging agent was first proposed by Kawana and associates [3]. In 1976, Ritchie and associates described thallium-201 myocardial imaging with exercise [4]. If the post exercise thallium images were abnormal, the patient returned to the laboratory at least 72 hours later for a study at rest. If the thallium image defect was no longer present, then transient exercise-induced myocardial...
ischemia was said to be present during the first study. If the thallium image defect was still present on the rest study, then a myocardial scar was said to be present. In 1977, Pohost and associates described a single thallium dose technique for exercise imaging [5]. Thallium imaging was repeated at least two hours after the initial post-exercise thallium images had been collected. If an initial defect were no longer present (transient defect), then transient exercise-induced myocardial ischemia was said to be present during exercise. If an initial defect were still present two hours later (persistent defect), then a myocardial scar was said to be present. This thallium redistribution technique is now universally utilized due to the reduced cost, radiation burden, and patient and laboratory time commitment.

**Thallium kinetics**

After intravenous thallium administration, blood levels are initially high, but then fall rapidly. Normally perfused myocardial cells initially equilibrate with blood containing the high thallium levels. Peak myocardial activities are attained after 10 to 25 minutes in normal myocardium [6]. The extraction fraction by the myocardium is approximately 85% [7]. The initial distribution after an intravenous injection is related to myocardial blood flow. Thus areas of ischemia as well as scar demonstrate decreased thallium activity initially. The attainment of peak myocardial thallium levels is delayed in ischemic myocardium [8].

After reaching peak activity, myocardial thallium clearance from normally perfused zones is monoexponential and parallels the clearance from the blood [8]. After ischemia myocardial zones attain a delayed peak activity, the subsequent clearance is slowed compared to normal. The thallium clearance from the normally perfused zones at a time when thallium activity is slowly increasing in ischemic zones accounts for the thallium redistribution seen on clinical images.

**Exercise thallium imaging**

**Protocol**

Thallium myocardial imaging, after the tracer has been administered during peak exercise, is widely used as a noninvasive test for coronary artery disease. In our laboratory, patients are usually exercised upright on a standard treadmill. Some patients are exercised supine using a specially