Evaluation of left ventricular wall motion, volumes, and ejection fraction by gated myocardial tomography with technetium 99m-labeled tetrofosmin: A comparison with cine magnetic resonance imaging

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Background. Whether left ventricular function can be assessed accurately by gated single photon emission computed tomography (SPECT) in patients with myocardial infarction and severe perfusion defects is not well known.

Methods and Results. Twenty-five patients with an acute myocardial infarction underwent 99mTc-labeled tetrofosmin (99mTc-tetrofosmin) gated SPECT and cine magnetic resonance imaging (MRI). Wall motion was assessed in 13 left ventricular segments using a 5-point scoring system ranging from 3 (normal) to -1 (dyskinetic). Exact agreement for wall motion scores between gated SPECT and MRI was excellent (92%, kappa = 0.82). Furthermore, correlations between the two techniques were also good for end-diastolic volume ($r = 0.81, P < .0001$), end-systolic volume ($r = 0.92, P < .0001$), and ejection fraction ($r = 0.93, P < .0001$).

Conclusion. In patients with a recent myocardial infarction, 99mTc-tetrofosmin gated SPECT provides reliable evaluation of global and regional ventricular function and volumes. (J Nucl Cardiol 1998;6:3-10.)

Key Words: Gated SPECT • cine magnetic resonance imaging • coronary artery disease • myocardial infarction

Single photon emission computed tomography (SPECT) can evaluate accurately myocardial perfusion and viability in patients with known or suspected coronary artery disease (CAD). Recently developed gated myocardial perfusion tomography allows simultaneous evaluation of myocardial perfusion and function and may improve the accuracy of myocardial scintigraphy for the diagnosis of CAD. The integrated information about myocardial perfusion and function may enhance the diagnostic value of the test and aid in management decisions for patients with CAD.

Both echocardiography and cardiac magnetic resonance imaging (MRI) correlate well with gated SPECT with respect to the assessment of left ventricular regional wall motion in patients with stable CAD. Several recent studies also have reported the accuracy of gated SPECT for measuring left ventricular ejection fraction (EF). However, the accuracy of gated SPECT for assessing left ventricular global and regional function in patients with severe perfusion defects caused by acute myocardial infarction (MI) has not been evaluated. Therefore, this study was prospectively designed to compare gated SPECT with MRI for the assessment of left ventricular global and regional function and volumes in patients with a recent MI.

METHODS

Study Design

Patients with an acute MI confirmed by serial electrocardiograms and creatine kinase MB (CK-MB) band levels were eligible for this study. This was not a consecutive series, but
was dictated by patients' clinical status (only patients in stable condition could be transported to the imaging suites), and equipment availability. Patients with the following conditions were excluded: cardiac pacemakers, intracranial aneurysm clips, unstable clinical conditions such as severe heart failure, hypotension or recurrent angina, second or third degree atrioventricular block, and atrial fibrillation. Premenopausal women also were excluded. All patients underwent resting gated SPECT and cine MRI within 48 hours of each other. The protocol was approved by the institutional review committee for human investigation.

We studied 25 patients with an acute MI, of whom 18 were men and 7 women, with a mean age of 64 ± 14 years (range 37 to 88 years). Gated SPECT and MRI were performed 5 ± 2 days and 6 ± 2 days, respectively, after the onset of MI. Gated SPECT was performed before MRI in 21 of 25 patients. All except 1 patient underwent coronary angiography, and 14 patients underwent contrast left ventriculography.

### Gated SPECT

$^{99m}$Tc-tetrofosmin (25 to 30 mCi) was administrated intravenously at rest. Electrocardiographic gated myocardial SPECT acquisition began 30 to 45 minutes after the tracer injection, using a 90-degree dual-head SPECT system (ADAC Vertex). A 20% window around the 140-keV energy peak of $^{99m}$Tc was used. Sixty-four projections (32 projections per detector) were obtained over an anterior 180-degree arc, from the 45-degree left posterior oblique to the 45-degree right anterior oblique views. Images were acquired for 30 seconds per projection at 8 frames per cardiac cycle. The total acquisition time was approximately 18 minutes.

Gated SPECT images were reconstructed using a backprojection algorithm and a three-dimensional Butterworth filter with a cutoff frequency of 35% of Nyquist frequency and order 5. The transaxial gated tomographic slices then were reoriented into the short, horizontal, and vertical long-axis views. The ungated projection data were created by summing the raw data acquired at each projection using a standard filtered backprojection algorithm.18

Gated SPECT images were visually interpreted (by MSV) without knowledge of the MRI results. The left ventricle was divided into 13 segments. The basal, mid, and distal short-axis slices were divided into 4 evenly spaced segments each (anterior, septal, posterior/inferior, and lateral wall) whereas the midvertical long-axis slice was scored for 1 apical segment. A 5-point scoring system was used to grade the wall motion on each segment, where 3 represented normal wall motion, 2 mild hypokinesis, 1 severe hypokinesis, 0 akinesis, and −1 dyskinesis. A summed wall motion score was calculated for each patient as the sum of the individual scores of the 13 segments.

Nongated SPECT images were used for the assessment of myocardial perfusion. Images were qualitatively and quantitatively interpreted (by MSV) using the techniques previously reported from our laboratory.18 Left ventricular volumes and EF were calculated from gated SPECT images using an automatic algorithm13 that segments the left ventricle, estimates endocardial and epicardial surfaces for all gating intervals in the cardiac cycle, calculates the end-diastolic volume (EDV) and end-systolic volume (ESV), and derives the global EF by dividing stroke volume (EDV-ESV) by EDV and expressing it as a percentage.

### Cine MRI

Cine MRI was performed with a Siemens 1.5-Tesla superconducting magnet. Acquisitions were electrocardiographically synchronized to the cardiac cycle. A fast imaging with steady state precession technique19 was used with flip angles of 30 and 60 degrees, a TE of 12 ms, and a TR of 50 ms. Slice thickness was 6 to 8 mm. The framing number was the maximum allowed by the RR interval of the patient's electrocardiogram, and was typically 10 to 16 frames. The acquisition matrix was $128 \times 256$, with interpolation to $256 \times 256$ during reconstruction. Coronal positioning sections were obtained, followed by axial positioning sections at the midventricular level. Vertical cardiac long axis sections were obtained through the left ventricle parallel to the interventricular septum. Horizontal cardiac long-axis sections were acquired through the center of the left ventricle as demonstrated by the vertical long axis sections. The long axis of the left ventricle was measured from the midpoint of the mitral valve annulus to the ven-