Myocardial perfusion scintigraphy with wall motion analysis is known to enhance accuracy in diagnosing ischemic heart disease. The purpose of this study is to determine the best method to evaluate regional wall motion in a gated planar perfusion study. Planar gated 99mTc tetrofosmin (GTF) study in two projections was performed after rest-exercise sequence SPECT studies (n = 29). To evaluate wall motion, cine-mode display, wall thickening, and inverted tetrofosmin studies including ventricular inner border tracing, segmental wall shortening and functional images were used. The results were compared with gated blood-pool (GBP) study in the same projections. In the GTF study, functional image identified asynergy significantly better than cinematic display. The best correlation between GTF and GBP studies was observed with functional images of phase and amplitude, with complete visual agreement seen in 145 of 168 (86%) segments. With quantitative analysis by means of regions of interest (n = 280), a good correlation was observed between GTF and GBP regarding regional amplitude (r = 0.78), regional phase (r = 0.84), average left ventricular phase (r = 0.91) and standard deviation of phase values (r = 0.90). The value for the count-based "ejection fraction" derived from inverted GTF showed insufficient correlation to that of the GBP study (r = 0.69). Functional imaging with myocardial perfusion imaging is a simple and effective means to evaluate ventricular asynergy. Similar diagnostic criteria to gated blood-pool imaging and comparable diagnostic accuracy are advantages of this approach.

Key words: myocardial perfusion, gated Tc-99m tetrofosmin study, gated blood-pool study, cardiac function

INTRODUCTION

Technetium-99m (99mTc) myocardial perfusion imaging agent has been found to be useful in coronary artery disease in evaluating ischemia, area at risk and myocardial viability. Currently both 99mTc sestamibi and 99mTc tetrofosmin are used.1-9 It is well recognized that wall motion abnormality has also important diagnostic and prognostic value both in nuclear studies and echocardiography.10 In comparison with a Tl-201 myocardial perfusion study, 99mTc radiopharmaceutical has advantages regarding the dose administered, higher photon flux and appropriate energy for data acquisition. This enables gated imaging and provides simultaneous assessment of perfusion and wall motion with a single injection.11-15 Gated single-photon emission computed tomography (SPECT) has recently been used.16-20 Although electrocardiography (ECG) gated SPECT acquisition can be performed with up-to-date SPECT equipment the longer acquisition time is preferable to increase the total count in gated images. Moreover, there is as yet no uniform processing method to integrate many gated tomographic slices. The idea of the planar gated perfusion image presented here is not new, but the quantification of left ventricular function by the method has not been estab-
Percutaneous transluminal coronary angioplasty had been performed in 12 patients, and coronary artery bypass grafting in three. Coronary angiography with cardiac catheterization was performed in 19 patients, and biplane left ventriculography was performed in 10 patients within 7 days of the nuclear study.

**Fig. 1** Regions of gated blood-pool study and gated tetrofosmin study in the LAO and RAO views. In visual interpretation of wall motion, left ventricle was divided into 3 regions for each view. In quantitative analysis, 5 rectangular regions of interest were selected for each view.

**Fig. 2** Planar gated $^{99m}$Tc tetrofosmin inversion to make Fourier functional images. Count-based “ejection fraction” was calculated by end-diastolic and end-systolic ventricular count.

Lished. Simple means that can be used with ordinary nuclear medicine equipment and processing programs would be convenient and useful. In this study, we proposed functional imaging in multiple projections based on count-inverted images of $^{99m}$Tc tetrofosmin and compared with the results of gated blood-pool studies.21-23 We evaluated the feasibility of functional images of gated myocardial perfusion scan and its clinical application as in gated radionuclide ventriculography.24-28

**MATERIALS AND METHODS**

**Patients**

Stress $^{99m}$Tc tetrofosmin myocardial scintigraphy was performed in 29 patients aged from 51 years to 80 years (20 males and 9 females, average 64 years, SD 11 years). Eleven patients had old myocardial infarction, 9 acute myocardial infarction, 1 angina pectoris, 4 valvular heart disease, 2 dilated cardiomyopathy, 1 hypertension and diabetes mellitus, and 1 suspected ischemic heart disease.

In the $^{99m}$Tc tetrofosmin study, 250 MBq was injected at rest and 740 MBq was injected at subsequent exercise study. After the second SPECT acquisition, planar gated tetrofosmin (GTF) acquisition was performed with 64 x 64 matrices, x 2 zoom, and 16 frames per cardiac cycle. The left anterior oblique (LAO) 35 to 45-degree best septal and right anterior oblique (RAO) 10-degree projections were obtained for 5 minutes each.

**Gated blood-pool study**

Gated blood-pool (GBP) study was performed within 5 days of the tetrofosmin study with 740 MBq of in vivo $^{99m}$Tc red blood cell labeling. Identical LAO and RAO projection angles were used in the GBP and GTF studies. In 2 patients, only LAO views were obtained. A cardiac cycle was divided into 24 frames with 64 x 64 matrices. Count loss of the last frames caused by heart rate variation was corrected for both tetrofosmin and gated blood-pool studies.

**Analysis of wall motion by gated tetrofosmin study**

**Cine-mode display.** In the visual cine-mode display, the left ventricle was divided into 3 regions, i.e., anteroseptal, inferoapical and posterolateral segments in the LAO view, and anterolateral, apical and inferior segments in the RAO view (Fig. 1). The degree of asynergy was visually classified as normokinesis, hypokinesis, severe hypokinesis, akinesis and dyskinesis. Two factors that influence our impression, i.e., movement of the inner edge of myocardium and wall thickening, should be considered.

**Wall thickening.** Five rectangular regions of interest (ROIs) of 4 x 4 or 5 x 5 pixels were set on each myocardial wall in end-diastolic (ED) and end-systolic (ES) frames, and the average count per pixel was calculated. The ROIs were placed in the anterobasal, anterolateral, apical, inferior and basal inferior segments in the RAO projection, and posterolateral, inferolateral, apical, distal septal and basal septal segments in the LAO projection, as in Fig. 1. The background was drawn on the lung along the left ventricle. Wall thickening was defined as (mean ES count – mean ED count) divided by (mean ED count – mean background count).

**Inverted tetrofosmin images.** The following four methods are based on inverted tetrofosmin images. The method is schematically explained in Fig. 2. The original image was filtered with 9-point weighted spatial smoothing and 3-point 1:2:1 temporal smoothing. The myocardium