

---

# Duodenogastric Reflux on $^{99m}\text{Tc}$ -Tetrofosmin Myocardial SPECT Mimics Left Ventricle Inferior Wall Reverse Redistribution and Falsely Decreases Ejection Fraction: A Case Report

Patrick Donovan, Vickie Kieffer, and Wei-Jen Shih

Section of Cardiology, Medicine Service, and Nuclear Medicine Service, Lexington VA Medical Center, Lexington; and Department of Medicine and Nuclear Medicine Section, Department of Diagnostic Radiology, College of Medicine, University of Kentucky, Lexington, Kentucky

---

$^{99m}\text{Tc}$ -labeled myocardial perfusion agents are excreted through the hepatobiliary system and can be used in the evaluation of the duodenogastric reflux that occurs during routine cardiac imaging. The resultant gastric activity can overlap the inferior wall of the left ventricle (LV) and can thus mimic reverse redistribution of the LV inferior wall on dual-isotope SPECT. We report a case of significant gastric activity, which leads to abnormally low LV ejection fraction and akinesis of the LV wall in addition to the appearance of reverse redistribution. This case report illustrates that care should be taken in the performance and interpretation of  $^{99m}\text{Tc}$ -tetrofosmin SPECT in the presence of duodenal reflux. This condition could be mistaken for reverse redistribution in the inferior wall of the LV with concomitant underestimation of the LV and regional wall motion.

**Key Words:** myocardial perfusion agents; duodenogastric reflux; reverse redistribution;  $^{99m}\text{Tc}$ -tetrofosmin

*J Nucl Med Technol* 2001; 29:193–196

**A**utomatic electrocardiogram (ECG)-gated myocardial SPECT has become a widely used technique for simultaneous assessment of myocardial perfusion and left ventricular (LV) function (1).  $^{99m}\text{Tc}$ -tetrofosmin is a new lipophilic diphosphine cationic radiopharmaceutical that is used for myocardial perfusion SPECT. SPECT with subsequent determination of the LV volume and ejection fraction using  $^{99m}\text{Tc}$ -tetrofosmin has been validated (2).  $^{99m}\text{Tc}$ -tetrofosmin is predominantly cleared by the liver and excreted rapidly by the biliary system. The presence of subdiaphrag-

matic activity, such as liver, bowel, and gallbladder activity, does not interfere with imaging interpretation in most patients. However, significant duodenogastric reflux can occur, and intense gastric activity can partially obscure the myocardial uptake of  $^{99m}\text{Tc}$  myocardial perfusion agents (3–5). We report here the case of a patient with duodenogastric reflux on  $^{99m}\text{Tc}$ -tetrofosmin myocardial SPECT, which resulted in falsely lower LV ejection fraction and the mimicking of reverse redistribution.

## CASE REPORT

A 70-y-old man was admitted to the hospital with a nonhealing left lower extremity ulcer. He was found to have significant left iliac and superior femoral artery stenosis, and lower extremity surgical revascularization was planned. His past medical history was significant and included a 40-y history of type II diabetes mellitus, end-stage renal disease, peripheral vascular disease, chronic obstructive pulmonary disease, and hypertension. He had no history of coronary artery disease, and his echocardiogram performed 2 wk before admission showed normal LV systolic function with an ejection fraction of 60% and an elevated estimated right ventricular systolic pressure of 57 mm Hg.

Prior (2 y)  $^{201}\text{Tl}$ -chloride myocardial SPECT showed mild hypoperfusion of the inferior wall of the left ventricle. As part of the presurgical evaluation for revascularization of the left lower extremity, the patient underwent dual radionuclide (dipyridamole  $^{99m}\text{Tc}$ -tetrofosmin/ $^{201}\text{Tl}$ -chloride rest) SPECT. Sixty minutes after intravenous administration of 925 MBq (25 mCi)  $^{99m}\text{Tc}$ -tetrofosmin, the patient was placed in a triple-head gamma camera (Prism; Phillips, Cleveland, OH), which was fitted with a low-energy, all-purpose collimator and interfaced with a 64-bit computer. The camera acquired 360° ECG-gated SPECT data in a

---

For correspondence or reprints contact: Dr. Wei-Jen Shih, Nuclear Medicine Service, Lexington VA Medical Center, Lexington, KY 40511; Phone: 859-381-5928; Fax: 859-381-5934.

64 × 64 matrix, 40 steps × 25 s with 3° angular range at magnification, ×1.33; 180° of filtered backprojected data were processed using ramp prefilter, and the SPECT images (short-axis, horizontal long, and vertical long) were reconstructed using a low-pass filter (order, 5.0; cutoff frequency, 0.22), using no attenuation correction.

The LV appeared to be thickened, and a large area of intense uptake inferior to the LV at stress was evident. Radioactive uptake in the inferior wall of the LV at stress was slightly higher than on rest, best shown on the vertical longitudinal-axis image (Fig. 1). Gated <sup>99m</sup>Tc-tetrofosmin cardiac SPECT showed severe hypokinesis in the inferior wall. The LV ejection fraction was 38% (*n* ≥ 50%). Polar mapping showed virtually absent wall motion in the inferior wall and an area of intense radioactivity in the region of the inferior wall, in the 5–6 o'clock region (Fig. 2). Raw data image showed the liver and gallbladder and a large amount of radioactivity in the stomach area (Fig. 3).

Two days after myocardial SPECT was performed, the patient underwent an amputation of the left leg below the knee; the patient tolerated the surgical procedures well. The postoperative course was uneventful; histopathologic results of the amputation were reported as ischemic necrosis, arteriosclerosis, and viable soft tissue margin.

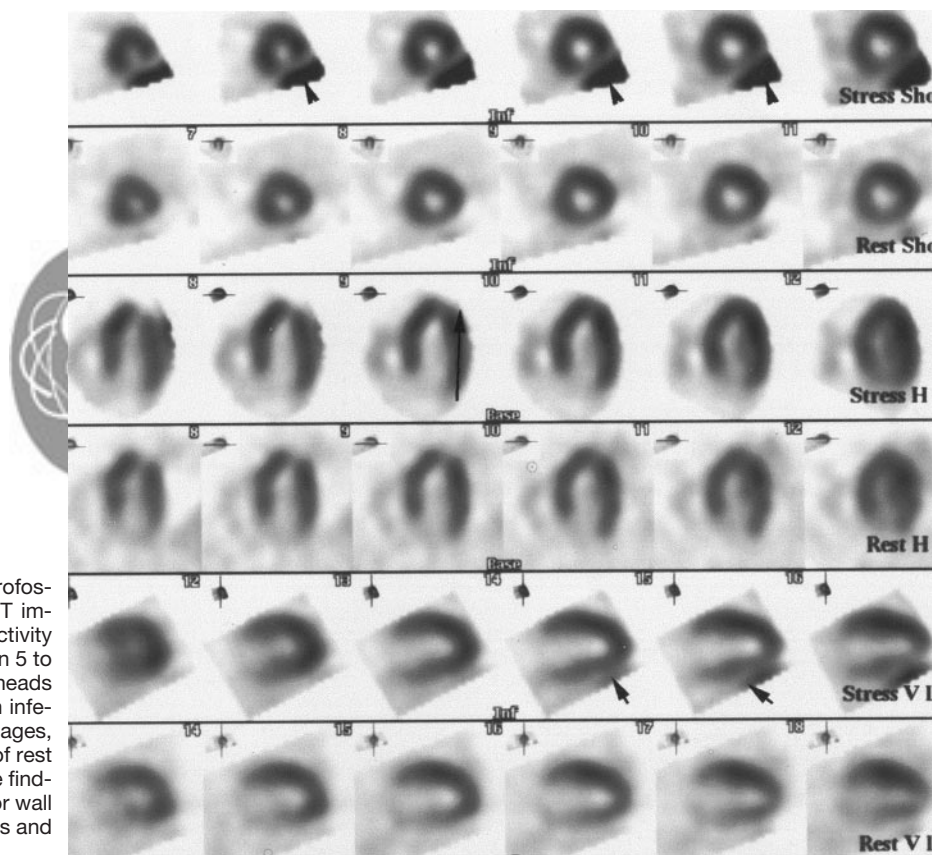
## DISCUSSION

On <sup>99m</sup>Tc-tetrofosmin myocardial SPECT the two artifacts, reverse redistribution of the LV inferior wall and

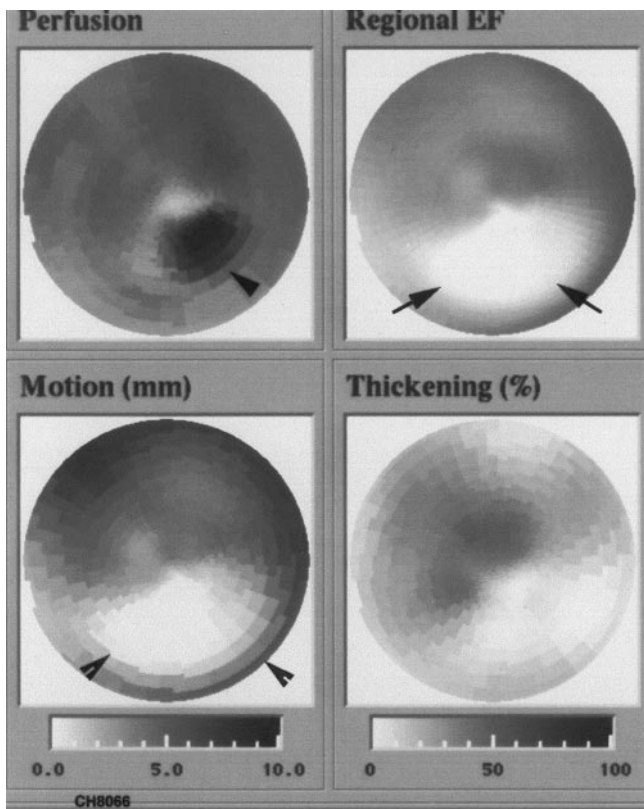
falsely lower LV ejection fraction, resulted from a large amount of radiotracer in the stomach secondary to duodenogastric reflux.

Duodenogastric reflux during administration of <sup>99m</sup>Tc-labeled myocardial perfusion agents for myocardial SPECT was previously reported (3–8). Duodenogastric reflux was reported in 8.3% of patients undergoing <sup>99m</sup>Tc-sestamibi cardiac imaging (6), and the reflux is seen more commonly after pharmacologic stress than after exercise stress testing, as well as in patients older than 40 y (6,7). Reflux resulting in halo or spillover effects has been well documented (5). Significant duodenogastric reflux can lead to the problem of overlapping gastric and myocardial activity and interference with the interpretation of myocardial uptake (3–5). <sup>99m</sup>Tc-tetrofosmin was retained in the stomach of our patient (Fig. 3), which appeared to be secondary to duodenogastric reflux. Intense gastric activity partially obscured the myocardial uptake, in which activity in the myocardium of the inferior wall of the LV resulted from the activity in the stomach, as seen in Figure 1. Our patient's significant gastric activity may result in reconstructive artifacts in SPECT imaging (9). This effect may result in an overestimation of inferior wall activity, leading to the mimicking of reverse redistribution on myocardial SPECT. This may also lead to virtually absent motion of the LV inferior wall in the ECG-gated cardiac SPECT, as shown in Figure 2, resulting in lower LV ejection fraction.

Although duodenogastric reflux with or without causative



**FIGURE 1.** Dipyridamole <sup>99m</sup>Tc-tetrofosmin–rest <sup>201</sup>Tl-chloride myocardial SPECT images show large area of intense radioactivity below and adjacent to inferior wall of LV in 5 to 6 o'clock region, as indicated by arrowheads on short-axis images (top row); activity in inferior wall, shown on vertical long-axis images, appears to be more prominent than that of rest (<sup>201</sup>Tl-chloride SPECT, lower panel); these findings mimic reverse redistribution of inferior wall of LV. Right ventricle is visualized at stress and on rest.



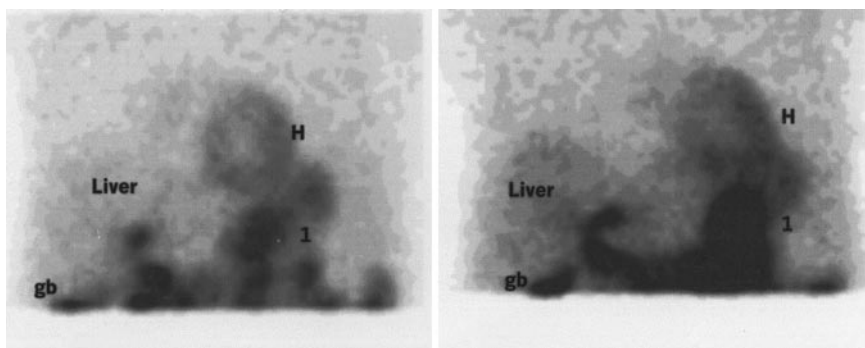
**FIGURE 2.** Polar map displaying results of perfusion from gated  $^{99m}\text{Tc}$ -tetrofosmin myocardial SPECT shows intense radioactivity in inferior portion, in 5 to 6 o'clock region (arrowhead, perfusion display). On wall motion display, there is an area of absent radioactivity (arrowheads). Absent regional ejection fraction (EF) in the regional EF display is indicated by arrows.

LV inferior effects on  $^{99m}\text{Tc}$ -labeled myocardial perfusion imaging has been well documented (3–8), no report, to our knowledge, shows that duodenogastric reflux has created abnormally lower LV ejection fraction or virtually absent motion of the inferior wall of the LV. Middleton and Williams (3) reported that the intense gastric activity secondary to significant gastric reflux of  $^{99m}\text{Tc}$ -labeled myocardial perfusion agents partially obscured myocardial uptake in the inferiorlateral wall of the LV. We present here that significant gastric activity can lead to abnormally lower LV ejection fraction and akinesis of the inferior wall of the LV, as well as reverse redistribution in the inferior wall of the

LV when a dual-isotope method has been used. The ejection fraction measured using gated SPECT was significantly lower than that of echocardiography findings (60%), which is considered a more reliable predictor of LV ejection fraction. In addition, the patient tolerated the major surgical procedures well, and the patient's postoperative course was uneventful.

On  $^{99m}\text{Tc}$ -labeled myocardial perfusion SPECT, abdominal activity, including activity from intestinal, hepatic, gallbladder, and entero gastric reflux, can adversely affect interpretation. Rehm et al. (10) reported that abdominal activity was a limitation to scan interpretation for 20 patients, and in 5 patients the inferior wall could not be evaluated. Significant entero gastric reflux secondary to Billroth II gastrectomy, resulting in reverse redistribution of the inferior wall of the LV on  $^{99m}\text{Tc}$ -tetrofosmin dipyridamole myocardial SPECT, has been reported (11). There are various ways to minimize subdiaphragmatic organ activity. Administration of both whole milk and water to the patient at testing time will improve the quality of attenuation-corrected myocardial perfusion SPECT, thus facilitating the interpretation of the inferoseptal wall (5). Milk is useful in emptying the gallbladder, which may solve the problem of a hot source scattering into the field of view; however, this may create a new problem—subdiaphragmatic intestinal activity. Repeating the study after drinking water and walking around may often help. In certain situations, antireflux drugs such as antacids or cimetidine may be used. Our routine myocardial SPECT procedure includes permitting the patient to eat a fatty snack consisting of a half-pint of milk, 1 oz. of peanut butter, and 8 saltine crackers 30 min after intravenous injection of tetrofosmin, to minimize the gastrointestinal activity. Despite the fatty meal given, our patient's duodenogastric reflux was very prominent. Whether this was related to our patient's longstanding history of type II diabetes was unknown; more patient studies are warranted.

Reverse redistribution, defined as the worsening of a perfusion defect during the redistribution phase of  $^{201}\text{Tl}$  scintigraphy, has been controversial. Some authors believe that this finding has clinical significance as a sign of myocardial viability in a previously damaged area with some myocardial necrosis and preserved perfusion, or by indicating the patency of an infarct-related artery and predicting the preserved LV function (12,13). Others consider this



**FIGURE 3.** Raw data images obtained from left anterior oblique (left) and anterior (right) views show areas of abnormal radiotracer accumulation in subdiaphragmatic region, including large amount of radioactivity in gastric region (1), below and overlapping inferior wall of LV (H). Gallbladder (gb) and liver are also identified.

finding to be secondary to most commonly artifactual evidence, arising from minor differences between 2 consecutive studies, and that it is a clinically irrelevant issue (12). The reverse redistribution seen in this  $^{99m}\text{Tc}$ -tetrofosmin myocardial SPECT appeared to be artifactual, secondary to high gastric activity resulting from the patient's significant duodenogastric reflux compared with the resting SPECT studies obtained with  $^{201}\text{Tl}$ -chloride.

Duodenogastric reflux can be shown on  $^{99m}\text{Tc}$ -labeled myocardial perfusion SPECT as the radiopharmaceutical agent is cleared by the hepatobiliary system, as seen in this patient. This resulted in overestimated LV inferior wall activity leading to mimicking of reverse redistribution on the SPECT. In addition, the abnormally localized radioactivity in the stomach was similar to the fixed motion of the inferior wall, resulting in akinesis of the LV inferior wall and reduced LV ejection fraction. Caution should be taken in the performance and interpretation of SPECT images in the presence of duodenogastric reflux, given that there may be an underestimation of the results of LV ejection fraction and regional wall motion.

#### ACKNOWLEDGMENTS

The authors express appreciation to Robert P. Fons and Jansen McDonald at Institutional Technology Center, University of Kentucky Medical Center, Lexington, KY, for their technical advice during the preparation of the illustrations.

#### REFERENCES

1. Germano G, Kiat H, Kavanagh PB, et al. Automatic quantification of ejection fraction from gated myocardial perfusion SPECT. *J Nucl Med.* 1995;36:2138–2147.
2. Yoshioka J, Hsaegawa S, Yamaguchi H, et al. Left ventricular volumes and ejection fraction calculated from quantitative electrocardiographic gated technetium-99m tetrofosmin myocardial SPECT. *J Nucl Med.* 1999;40:1693–1698.
3. Middleton GW, Williams JH. Significant gastric reflux of technetium-99m-MIBI in SPECT myocardial imaging. *J Nucl Med.* 1994;35:619–620.
4. Germano G, Chua T, Kiat H, Areeda JS, Berman DS. A quantitative phantom analysis of artifacts due to hepatic activity in technetium-99m myocardial perfusion SPECT studies. *J Nucl Med.* 1994;35:356–359.
5. van Dongen AJ and van Rijk PP. Minimizing liver, bowel, and gastric activity in myocardial perfusion SPECT. *J Nucl Med.* 2000;41:1315–1317.
6. Kabasakal L, Collier BD, Shaker R, et al. Enterogastric bile reflux during technetium-99m sestamibi cardiac imaging. *J Nucl Med.* 1996;37:1285–1288.
7. Bienenstock EA, Rush C. Tc-99m-sestamibi esophageal activity during myocardial imaging. *Clin Nucl Med.* 1998;23:259–261.
8. Araujo W, Kamran M, Mirzai M, et al. Esophageal and tracheal activity during myocardial scintigraphy with Tc-99m sestamibi: a case report. *Clin Nucl Med.* 2000;25:728–729.
9. Gillen GJ, McKillop JH, Hilditch TE, et al. Digital filtering of the bladder from SPECT bone studies of the pelvis. *J Nucl Med.* 1988;29:1587–1595.
10. Rehm PK, Atkins FB, Ziessman HA, et al. Frequency of extra-activity and its effect on Tc-99m MIBI cardiac SPECT interpretation. *Nucl Med Commun.* 1996;17:851–856.
11. Shih WJ, Donovan P, Kiffer V. Significant enterogastric reflux secondary to Billroth II gastrectomy leads to reverse redistribution of inferior wall of the left ventricle on dipyridamole myocardial SPECT. *Clin Nucl Med.* 2001; 26:543–545.
12. Nuclear Cardiology News Update. *J Nucl Cardiol.* 2000;7:403–404.
13. Takeishi Y, Sukekawa H, Fujiwara S, et al. Reverse redistribution of technetium-99m-sestamibi following direct PTCA in acute myocardial infarction. *J Nucl Med.* 1996;37:1289–1294.



The Technologist  
Section of the  
Society of  
Nuclear  
Medicine