Annals of Nuclear Medicine Vol. 15, No. 3, 277–280, 2001

Completely inverse images in dual-isotope SPECT with Tl-201 and I-123 MIBG in a patient with myocarditis

Tadaki NAKAHARA, Jun HASHIMOTO, Takayuki SUZUKI, Hirofumi FUJII and Atsushi KUBO

Department of Radiology, Keio University School of Medicine

Dual-isotope myocardial SPECT in a female patient with idiopathic myocarditis showed completely inverse images in Tl-201 and I-123 MIBG SPECT. In the dual-isotope SPECT performed 13 days after her admission, Tl-201 SPECT images showed reduced accumulation in the apex and normal accumulation in the other regions, whereas the corresponding I-123 MIBG SPECT images showed normal findings in the apex and reduced uptake in the other regions. These rare discrepancies were due to the difference in photon attenuation of the two isotopes in the apex and denervated-but-viable myocardium in the basal region, which were suggested by the following findings of gated perfusion SPECT and echocardiography. Gated SPECT with Tc-99m tetrofosmin performed 23 days after admission revealed normal myocardial perfusion and normal wall motion. Iodine-123 MIBG SPECT findings reflected impaired wall motion in echocardiography performed on admission, which resembles a phenomenon called "memory image" in coronary artery disease. The present case indicated a pitfall in interpreting dual-isotope imaging.

Key words: single-photon emission tomography (SPECT), thallium-201, iodine-123 MIBG, myocarditis

INTRODUCTION

MYOCARDIAL SCINTIGRAPHY with iodine-123 metaiodobenzylguanidine (I-123 MIBG) has been shown to be useful in evaluating the sympathetic nerve system in patients with various kinds of heart diseases including myocardial infarction, angina pectoris, congestive heart failure, cardiomyopathy, diabetic autonomic neuropathy and myocarditis.[1–19] The dual-isotope technique with thallium-201 (Tl-201) and I-123 MIBG is often used to differentiate coronary artery diseases from others because this method offers information regarding myocardial perfusion and cardiac denervation without misregistration.[5,10,11]

Previous reports have shown that the extent of I-123 MIBG defects is greater than that of Tl-201 defects in the majority of patients with heart diseases.[3–6] We recently encountered a patient with myocarditis in which the areas of Tl-201 and I-123 MIBG defects were quite different in single-photon emission tomography (SPECT). Although such findings were difficult to interpret, gated SPECT with technetium-99m (Tc-99m) tetrofosmin led us to the conclusion that Tl-201 images did not reflect true myocardial perfusion correctly. In addition, I-123 MIBG defects were concordant with the regions in which previous echocardiography showed impaired wall motion. In this article we discussed the pitfall in dual-isotope imaging and a role of I-123 MIBG SPECT.

CASE REPORT

A 32-year-old woman with nausea, vomiting and general fatigue was admitted to our hospital. She had an episode of common cold a week before admission. She bore a baby five months ago. On admission her systolic blood pressure was 79 mmHg, and the expansion of the jugular vein was observed. Other physical examinations were unremarkable. Laboratory data showed increased WBC

Received January 29, 2001, revision accepted March 22, 2001.

For reprint contact: Tadaki Nakahara, M.D., Department of Radiology, Keio University School of Medicine, 35 Shinanomachi, Shinjuku-ku, Tokyo 160–8582, JAPAN.

E-mail: n-tadaki@snu.ne.jp

(14,400 μl^{-1}), CPK (1,501 g/dl) and CRP (26.19 g/dl). An electrocardiogram showed a QS pattern in V_1 and V_2 leads, low voltage in extremity leads, and no evidence of ST segment abnormality. Echocardiography performed on admission showed diffuse, severe hypokinesis in the left ventricle except for the apical myocardium with modest hypokinesis. In spite of dopaminergic therapy, the cardiac index deteriorated and advanced atrioventricular block occurred. Afterwards heart failure was gradually improved by therapeutic pacing and percutaneous cardiopulmonary support. Coronary angiography performed soon after admission revealed no stenotic lesion, and endomyocardial biopsy showed edema, inflammatory and fibrotic changes compatible with myocarditis. As a result, the clinical diagnosis was idiopathic myocarditis because the patient did not have antibodies to various kinds of viruses in significant titers.

Dual-isotope myocardial SPECT with Tl-201 and I-123 MIBG were performed after remission of cardiac symptoms (10 days after admission). Dual scans were obtained 180 min after an intravenous injection of 111 MBq of I-123 MIBG and 111 MBq of Tl-201 (Daiichi Radioisotope Labs., Tokyo). Two energy windows were used for Tl-201 (71 ± 7 keV) and I-123 MIBG (159 ± 16 keV). Compensation for crosstalk was not performed. Vertical long-, horizontal long- and short-axis images were reconstructed with a ramp filter after processing with a Butterworth filter (order, 8; cut-off frequency, 0.30 cycles/pixel).

Thallium-201 SPECT images showed reduced accumulation in the apex and normal accumulation in the other regions, whereas the corresponding I-123 MIBG SPECT images showed normal findings in the apex and reduced uptake in the other regions (Fig. 1). Completely reverse images of dual SPECT were evident in the bull's eye map (Fig. 2).

To explore the reason for these uncommon findings, gated SPECT with Tc-99m tetrofosmin was performed 13 days after dual-isotope examination. There were no remarkable changes in the patient's condition and no interventional treatment between dual-isotope and gated SPECT. Gated SPECT showed almost normal myocardial perfusion and wall motion (Fig. 3). To assess activity of myocarditis, myocardial SPECT with gallium-67 (Ga-67) was performed, which showed no accumulation in the myocardium, suggesting remission of myocarditis. On the other hand, increased uptake in the breasts was noted (Fig. 4).

DISCUSSION

Two major findings in the present case were (1) discrepancy between gated SPECT showing normal myocardial perfusion with good wall motion and Tl-201 SPECT showing a perfusion defect in the apex and (2) concordance between the findings of I-123 MIBG SPECT and previous echocardiography.

The former is probably due to differences in the effects of breast attenuation on Tl-201 and Tc-99m SPECT images. Some photons emitted from the radiopharmaceuticals in the myocardium are attenuated in the body, especially in the breast and diaphragm. Photon attenuation is significant in Tl-201 SPECT because photon energy of Tl-201 (71 keV) is lower than that of Tc-99m (159 keV). The patient's breasts were relatively big as shown in Ga-67 scintigraphy, which accounts for the marked effect of breast attenuation on Tl-201 SPECT images resulting in reduced accumulation in the apex. In addition, gated SPECT supports our explanation by demonstrating normal wall motion and perfusion in the apex.

Cardiac denervation remains after successful reperfusion therapy or coronary artery spasm in the area with restored perfusion.[2,6–8] In such areas, I-123 MIBG uptake is impaired in contrast with relatively preserved accumulation of perfusion tracers. This phenomenon is referred to as "memory image" because the I-123 MIBG image reflects past ischemic events even if the tracer was injected after the complete recovery from ischemia. In the present study reduced I-123 MIBG uptake was observed after the inflammation subsided, which resembles the "memory image" in coronary artery disease.

The final diagnosis was idiopathic myocarditis, although the patient's episodes and symptoms suggested viral myocarditis. It is thought that the major cause of myocarditis is viral infection. Nevertheless, serum antibodies to viruses cannot be proven in most patients with viral myocarditis, which is diagnosed as idiopathic myocarditis. One possible differential diagnosis is peripartal cardiomyopathy which is characterized by myocarditis-like clinical symptoms in the peripartal period, but peripartal cardiomyopathy is reported to occur usually within 1 month after delivery; this is not consistent with the onset and course in our patient.

In summary, we have presented a patient with myocarditis in which dual-isotope SPECT demonstrated unexpected discrepancies between Tl-201 and I-123 MIBG images. The results of gated SPECT suggested that Tl-201 SPECT showing a perfusion defect in the apex was due to photon attenuation caused by the breasts, and the results of echocardiography performed on admission suggested the presence of cardiac damage caused by myocarditis, which I-123 MIBG could depict even after remission of the disease. When interpreting dual-isotope SPECT images, it is important to consider the effects of photon attenuation of the two isotopes. Information about cardiac wall motion is helpful in the judgment of artifacts.

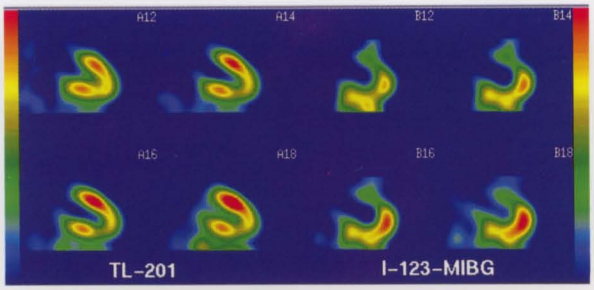

Fig. 1 Vertical long-axis images in dual-isope single-photon emission tomography (SPECT). Left, thallium-201 images; Right, iodine-123 MIBG images.

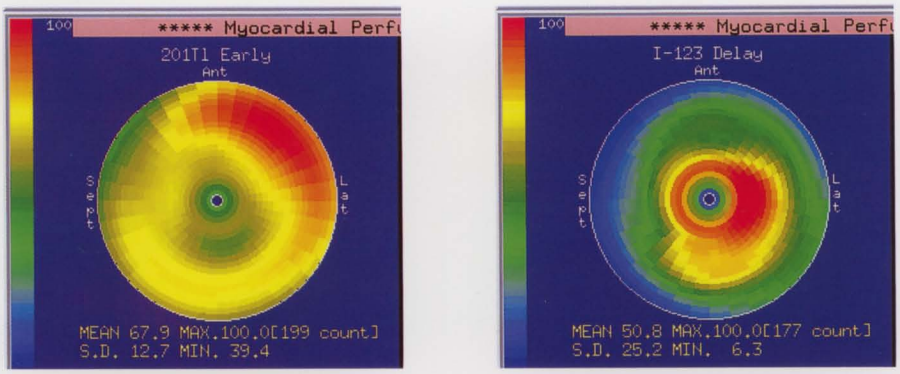

Fig. 2 Bull's eye maps generated from thallium-201 (left) and iodine-123 MIBG (right) images.

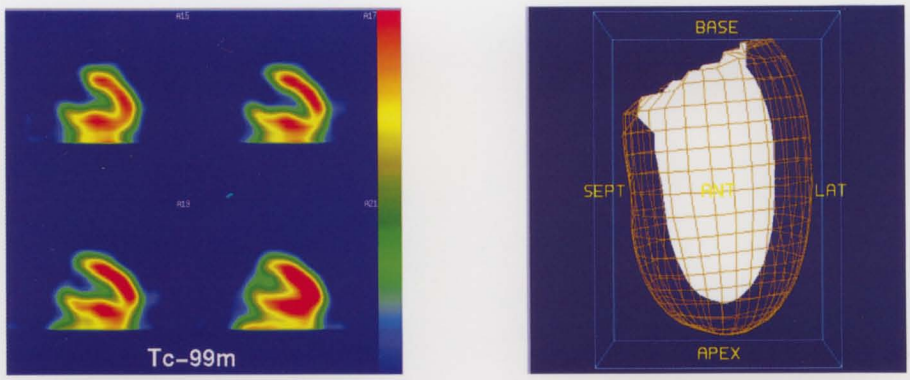

Fig. 3 The results of gated single-photon emission tomography. Left, perfusion images; Right, gated analysis: white part, endocardial surface at end-systolic phase; grid, endocardial surface at end-diastolic phase

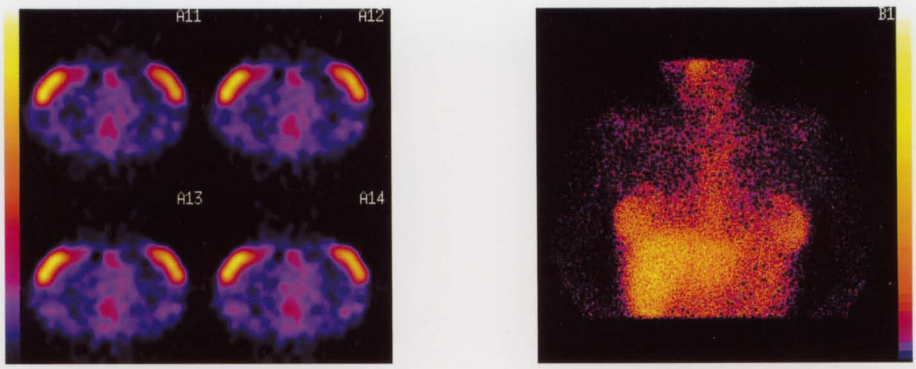

Fig. 4 Gallium-67 images. SPECT image (left), Planar image (right).

REFERENCES

1. Spinnler MT, Lombardi F, Moretti C, Sandrone G, Podio V, Spandonari T, et al. Evidence of functional alterations in sympathetic activity after myocardial infarction. *Eur Heart J* 1993; 14: 1334–1343.
2. Abe Y, Sugiura T, Suga Y, Takehana K, Kamihata H, Karakawa M, et al. Serial assessment of sympathetic reinnervation in a patient with myocardial infarction. *J Nucl Med* 1997; 38: 457–459.
3. Lekakis J, Antoniou A, Vassilopoulos N, Tsinikas D, Palaistides C, Kostamis P, et al. I-123 metaiodobenzylguanidine—thallium-201 mismatch following myocardial infarction. *Clin Cardiol* 1994; 17: 21–25.
4. Hartikainen J, Mustonen J, Kuikka J, Vanninen E, Kettunen R. Cardiac sympathetic denervation in patients with coronary artery disease without previous myocardial infarction. *Am J Cardiol* 1997; 80: 273–277.
5. Tsutsui H, Ando S, Fukai T, Kuroiwa M, Egashira K, Sasaki M, et al. Detection of angina-provoking coronary stenosis by resting iodine 123 metaiodobenzylguanidine scintigraphy in patients with unstable angina pectoris. *Am Heart J* 1995; 129: 708–715.
6. Kodama K, Igase M, Kazatani Y, Matsuzaki K, Murakami E, Kokubu T. Detection of perioperative coronary vasospasm on iodine-123-MIBG, Thallium-201 and Iodine-123-BMIPP myocardial SPECT images. *J Nucl Med* 1995; 36: 2050–2052.
7. Inobe Y, Kugiyama K, Miyagi H, Ohgushi M, Tomiguchi S, Takahashi M, et al. Long-lasting abnormalities in cardiac sympathetic nervous system in patients with coronary spastic angina: quantitative analysis with iodine 123 metaiodobenzylguanidine myocardial scintigraphy. *Am Heart J* 1997; 134: 112–118.
8. Taki J, Yasuhara S, Takamatsu T, Nakajima K, Tatami R, Ishise S, et al. Value of iodine-123 metaiodobenzylguanidine scintigraphy in patients with vasospastic angina. *Eur J Nucl Med* 1998; 25: 229–234.
9. Merlet P, Valette H, Dubois-Randé JL, Moyse D, Duboc D, Dove P. Prognostic value of cardiac metaiodobenzylguanidine imaging in patients with heart failure. *J Nucl Med* 1992; 33: 471–477.
10. Simmons WW, Freeman MR, Grima EA, Hsia TW, Armstrong PW. Abnormalities of cardiac sympathetic function in pacing-induced heart failure as assessed by [^{123}I]metaiodobenzylguanidine scintigraphy. *Circulation* 1994; 89: 2843–2851.
11. Yamakado K, Takeda K, Kitano T, Nakagawa T, Futagami Y, Konishi T, et al. Serial change of iodine-123 metaiodobenzylguanidine (MIBG) myocardial concentration in patients with dilated cardiomyopathy. *Eur J Nucl Med* 1992; 19: 265–270.
12. Henderson EB, Kahn JK, Corbett JR, Jansen DE, Pippin JJ, Kulkarni P, et al. Abnormal iodine-123 metaiodobenzylguanidine myocardial washout and distribution may reflect myocardial adrenergic derangement in patients with congestive cardiomyopathy. *Circulation* 1988; 78: 1192–1199.
13. Murata K, Kusachi S, Murakami T, Nogami K, Murakami M, Hirohata S, et al. Relation of iodine-123 metaiodobenzylguanidine myocardial scintigraphy to endomyocardial biopsy findings in patients with dilated cardiomyopathy. *Clin Cardiol* 1997; 20: 61–66.
14. Merlet P, Dubois-Randé JL, Adnot S, Bourguignon MH, Benvenuti C, Loisance D, et al. Myocardial beta adrenergic desensitization and neuronal norepinephrine uptake function in idiopathic cardiomyopathy. *J Cardiovasc Pharmacol* 1992; 19: 10–16.
15. Hattori N, Tamaki N, Hayashi T, Masuda I, Kudoh T, Tateno M, et al. Regional abnormality of iodine-123-MIBG in diabetic hearts. *J Nucl Med* 1996; 37: 1985–1990.
16. Mantysaari M, Kuikka J, Mustonen J, Tahvanainen K, Vanninen E, Lansimies E, et al. Noninvasive detection of cardiac sympathetic nervous dysfunction in diabetes patients using ^{123}I-metaiodobenzylguanidine. *Diabetes* 1992; 41: 1069–1075.
17. Nagamachi S, Jinnouchi S, Kurose T, Ohnishi T, Flores II LG, Nakahara H, et al. ^{123}I-MIBG myocardial scintigraphy in diabetic patients: relationship with ^{201}Tl uptake and cardiac autonomic function. *Ann Nucl Med* 1998; 12: 323–331.
18. Agostini D, Babatasi G, Manrique A, Saloux E, Grollier G, Potier JC, et al. Impairment of cardiac neuronal function in acute myocarditis: iodine-123-MIBG scintigraphy study. *J Nucl Med* 1998; 39: 1841–1844.
19. Kinoshita T, Itoh H, Takahashi K, Takeda H. Myocardial imaging with I-123 MIBG and Tl-201 demonstrates denervated but viable myocardium in a patient with myocarditis. *Clin Nucl Med* 1994; 19: 649–650.