Abnormal Accumulation on Technetium-99m-Pyrophosphate Myocardial Scintigraphy in Chronic Renal Failure Associated with Ischemic Heart Disease

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Abstract

There have been a few reports of a persistently abnormal “doughnut” pattern on technetium-99m-pyrophosphate (99mTc-PYP) myocardial scintigraphy in maintenance hemodialysis patients with severe ischemic heart disease. The present patient was a 65-year-old woman who had suffered from diabetes mellitus since the age of 46 years and had been on chronic hemodialysis because of diabetic nephropathy since the age of 62 years. She had no definite history of angina. Despite repeated episodes of congestive heart failure, she had been maintained on intensive hemodialysis and extracorporeal ultrafiltration method for two years. She complained of the sudden onset of chest pain on March 31, 1998. The electrocardiogram showed sinus tachycardia and there was 1-3mm of ST depression in leads V3-V6. Creatine phosphokinase (CPK) was 528IU/l and CRP was 4.1mg/dl. Echocardiography revealed anteroseptal hypokinesis. Myocardial scintigraphy using technetium-99m tetrofosmin (99mTc-tetrofosmin) showed defects in the anterior and posterolateral walls, and 99mTc-PYP showed a “doughnut” pattern of cardiac uptake. Coronary arteriography demonstrated 99% stenosis of seg. 1, 75% stenosis of seg. 7, 99% stenosis of seg. 9, and total obstruction of seg. 11 (AHA classification). Five months later, 99mTc-PYP myocardial scintigraphy showed persistence of the abnormal “doughnut” pattern of cardiac uptake. The endocardial biopsy specimen from the right ventricle revealed ischemic cardiomyopathy. Six months later, she died of congestive heart failure. 99mTc-PYP myocardial scintigraphy may be a practical and noninvasive means of diagnosing severe ischemic heart disease in patients with chronic renal failure secondary to diabetic nephropathy.
Introduction
Cardiovascular disease is the main cause of death in patients on maintenance hemodialysis and diabetes mellitus causes an increase of cardiovascular mortality. Therefore, we need to detect cardiovascular disease in maintenance hemodialysis patients at an early stage.

The potential use of technetium-99m-pyrophosphate (\textsuperscript{99m}Tc-PYP) myocardial scintigraphy for noninvasive identification of myocardial necrosis and cardiac amyloidosis has been reported. There have also been a few reports that patients with diabetes mellitus and severe ischemic heart disease have a persistently abnormal "doughnut" pattern on \textsuperscript{99m}Tc-PYP myocardial scintigraphy.

Here we describe an unusual patient with abnormal accumulation of \textsuperscript{99m}Tc-PYP who was on chronic hemodialysis for diabetic nephropathy and also had severe ischemic heart disease.

Case Presentation
The patient was a 65-year-old woman, who had no relevant family history. She had a past history of diabetes mellitus since the age of 46 years and she had been on hemodialysis because of diabetic nephropathy for two years. She had no chest pain or chest tightness indicating angina. Although she had repeated episodes of congestive heart failure, she had been maintained on intensive hemodialysis and extracorporeal ultrafiltration method for two years. There was a sudden onset of chest pain and chest oppression on March 31, 1998. Physical examination revealed that she was well nourished, with audible moist rales and a systolic ejection murmur on auscultation, as well as facial and leg edema. Her blood pressure was 122/84mmHg and the pulse rate was 120/min. Laboratory data on admission were as follows: WBC was 8,400/\mu l, CRP was 4.1 mg/dl, CPK was 528 IU/l, and myosin light chain was 3.2 ng/ml. The serum urea nitrogen level was 48.5 mg/dl, creatinine was 7.1 mg/dl, blood glucose was 389 mg/dl, HbA1c was 10.1%, and total cholesterol was 216 mg/dl.

A plain chest X-ray revealed a cardiothoracic ratio of 56%. The electrocardiogram disclosed sinus tachycardia, low voltages in the limb leads and 1-3mm ST depression in leads V\textsubscript{3}-V\textsubscript{6} (Fig. 1). Echocardiography revealed diffuse hypokinesis of the left ventricle, with an ejection fraction of 25%, an end-diastolic dimension of 58mm, an end-systolic dimension of 51mm, and mitral regurgitation. We used a rotating gamma camera (GC-901 ASB, Toshiba, Inc) fitted with a low-energy, high-resolution, parallel-hole collimeter. Thirty-two projections were acquired on a 64\times64 matrix for 30 seconds each over an arc of 180° extending clockwise from the 45° right anterior oblique position to the left posterior oblique position. To reconstruct transaxial tomographic images from the data, Shepp and Logen filters were used. Perfusion studies were done at rest after the intravenous injection of \textsuperscript{201}TI (3 mCi, 111 MBq) and \textsuperscript{99m}Tc-tetrofosmin (20 mCi, 740 MBq). Myocardial scintigraphy using \textsuperscript{99m}Tc-tetrofosmin showed reduced uptake in the anterior wall and a defect extending from the lateral wall to the posterior wall, while \textsuperscript{201}TI scintigraphy also disclosed a defect extending from lateral to posterior wall (Fig. 2 (A), (B)). After \textsuperscript{99m}Tc-PYP (9.5 mCi, 350 MBq) was injected intravenously, myocardial scintigraphy revealed a "doughnut" pattern of uptake by the heart (Fig. 3). At cardiac catheterization, coronary arteriography demonstrated 99% stenosis of seg. 1 (Fig. 4 (A)), 75% stenosis of seg. 7, 99% stenosis of seg. 9, and total occlusion of seg. 11 (Fig. 4 (B)).

![Fig. 1 Electrocardiogram discloses sinus tachycardia, low voltages in limb leads and 1-3mm ST depression in leads V\textsubscript{3}-V\textsubscript{6}](image)

![Fig. 2 \textsuperscript{201}TI myocardial scintigraphy discloses a defect extending from the lateral to posterior wall (A). Rest \textsuperscript{99m}Tc-tetrofosmin myocardial scintigraphy shows reduced uptake in the anterior wall and a defect extending from the lateral wall to posterior wall (B).](image)
according to the AHA classification. From these findings, a diagnosis of acute myocardial infarction was confirmed, so she was treated with heparin and other drugs. Five months later, $^{99m}$Tc-PYP myocardial scintigraphy disclosed persistence of the abnormal “doughnut” pattern of cardiac uptake (Fig. 3). Left ventriculography showed diffuse hypokinesis and the ejection fraction was 24% (Fig. 5), while coronary arteriography revealed total occlusion of seg. 1, 75% stenosis of seg. 7, and total occlusion of both seg. 9 and seg. 11. Revascularization was unsuccessful in the acute and chronic stages of myocardial infarction despite attempts at percutaneous transluminal coronary angioplasty and stenting because of her narrow arteries. Transvenous right ventricular endomyocardial biopsy was performed and a diagnosis of ischemic cardiomyopathy was established (Fig. 6). Six months later, she died of congestive heart failure.

Discussion

Despite the many technical advances in medical care and in the delivery of dialysis, mortality and morbidity remain high in patients on maintenance hemodialysis. Cardiovascular disease is the main cause of death, and many factors such as volume overload, hypertension,
anemia, arteriovenous fistula, and uremic substances may contribute to the development of ischemic heart disease and congestive heart failure\(^1\). In addition, the underlying disease is a determinant of the prognosis, with diabetes mellitus promoting an increase of cardiovascular mortality. Therefore, it is important to detect the cardiovascular disease at an early stage in maintenance hemodialysis patients. Myocardial scintigraphy is a simple and useful method for the diagnosis of cardiac disease because it is a noninvasive examination.

\(^{99m}\text{Tc-PYP myocardial scintigraphy has been reported to be a highly sensitive indicator of myocardial necrosis in patients with acute myocardial infarction and reinfarction}\(^2\). In most patients with acute infarction, the \(^{99m}\text{Tc-PYP myocardial scintigram becomes abnormal from 12 to 24 hrs after maximal chest pain, with an increase in intensity over the next 48 to 72 hours and a decrease in intensity thereafter, and the test usually become negative from one to two weeks after infarction}\(^3\). Persistently abnormal \(^{99m}\text{Tc-PYP myocardial scintigrams are seen in 10% to 56% of patients following acute myocardial infarction and appear to be correlated with: (A) recurrent hospital admission for chest pain or congestive heart failure, (B) an increased incidence of refractory congestive heart failure, (C) severe angina pectoris, and (D) an increased risk of cardiac death and nonfatal myocardial infarction}\(^6\). The present patient fitted into categories (A), (B) and (C).

Patients with diabetes mellitus have a significantly greater incidence of persistently abnormal findings on \(^{99m}\text{Tc-PYP myocardial scintigraphy after acute myocardial infarction than non-diabetic patients. Persistent abnormalities on \(^{99m}\text{Tc-PYP myocardial scintigraphy were seen in 62% of diabetic patients versus only 12% of non-diabetic patients}\(^8\). Furthermore, a persistently abnormal pattern on \(^{99m}\text{Tc-PYP myocardial scintigraph} appears to be associated with chronic myocardial injury in diabetic patients, as evidenced by an increased incidence of ischemic heart disease complications during follow-up and at postmortem\(^6\). Thus, patients with diabetes mellitus have an increased incidence of persistent abnormal findings on \(^{99m}\text{Tc-PYP myocardial scintigraphy after myocardial infarction and a relatively poor prognosis, like our case. Our patient had no history of angina attacks, and diabetic patients with ischemic heart disease often have asymptomatic angina like the present case. In fact, our patient had severe ischemic heart disease (three-vessel involvement) at the onset of acute myocardial infarction.

Forty percent of patients with myocardial infarction show a doughnut pattern of tracer uptake\(^9\). The doughnut pattern of \(^{99m}\text{Tc-PYP uptake is characterized by relatively intense peripheral uptake surrounding a central zone of decreased uptake and extends over a large part of the anterior surface of the left ventricle}\(^10\). The detection of such a pattern on \(^{99m}\text{Tc-PYP myocardial scintigraphy appears to indicate the following: 1) anterior or
anterolateral infarction that is approximately twice as extensive as similar lesions without a doughnut pattern; 2) a high incidence of congestive heart failure as a complication of acute myocardial infarction; and 3) the presence of either complete occlusion or severe narrowing of the proximal left anterior descending artery. Thus, several reports have shown that a doughnut pattern on 99mTc-PYP myocardial scintigraphy is of prognostic importance, as it was in the present case. In conclusion, 99mTc-PYP myocardial scintigraphy is useful when screening for ischemic heart disease and when predicting the prognosis of patients with diabetes mellitus on maintenance hemodialysis.

References