Assessment of myocardial fatty acid metabolic abnormalities in patients with idiopathic dilated cardiomyopathy using ^{123}I BMIPP SPECT: correlation with clinicopathological findings and clinical course

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Abstract

***Objective*—To determine the clinical and prognostic value of identifying metabolic abnormalities of myocardial fatty acid metabolism in idiopathic dilated cardiomyopathy using iodine-123 β-methyl-iodophenyl pentadecanoic acid (^{123}I BMIPP).**

***Setting*—Cardiac care division in national hospital.**

***Patients*—32 consecutive patients with idiopathic dilated cardiomyopathy in whom both ^{123}I BMIPP and thallium-201 myocardial single photon emission computed tomography were performed.**

***Methods*—The uptake of each tracer was scored visually from 0 (normal) to 3 (defect) in 17 segments (eight basal, eight midventricular, and one apical). A total score for all 17 segments was compared with clinicopathological variables. Prognostic value of mismatches between the two tracers were also evaluated.**

***Results*—The ^{123}I BMIPP total score was correlated with pulmonary capillary wedge pressure (r = 0.68, p < 0.001), left ventricular end diastolic pressure (r = 0.65, p < 0.001), percentage fractional shortening at six months' follow up (r = -0.58, p = 0.001), myocyte diameter (r = 0.66, p < 0.001), and percentage area of interstitial fibrosis (r = 0.69, p < 0.001) measured by morphometry in the biopsy specimens. During a mean (SD) follow up of 20 (11) months, deterioration of the New York Heart Association functional class was observed in 11 of the 32 patients; four of these died. Segments with a greater decrease in ^{123}I BMIPP than thallium-201 uptake (type B mismatching) were often observed in patients with deterioration (88/187, 29% *v* 58/357, 16%; p < 0.001).**

***Conclusions*—The extent of the abnormality of myocardial fatty acid metabolism in idiopathic dilated cardiomyopathy reflects the severity of haemodynamic deterioration and histopathological changes. Type B mismatching is one of the important prognostic indicators in idiopathic dilated cardiomyopathy.**

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Keywords: idiopathic dilated cardiomyopathy; fatty acid metabolism; β-methyl-iodophenyl pentadecanoic acid

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As free fatty acids are the main energy source of the heart under aerobic conditions,[1 2] evaluation of myocardial fatty acid metabolism is useful in understanding pathophysiological conditions in various heart diseases. Up to now, the instability of labelling and the rapid catabolism in cardiac myocytes through the β oxidative pathway have precluded the use of iodine-123 labelled fatty acids[3 4] for single photon emission computed tomography (SPECT). Iodine-123 β-methyl-iodophenyl pentadecanoic acid (^{123}I BMIPP), which is trapped mainly in the triglyceride fractions[5 6] and is metabolised slowly by β oxidation,[7 8] is an analogue of iodine-123 free fatty acid. ^{123}I BMIPP is suitable for SPECT imaging because of its prolonged retention in the myocardium. Several investigators have used this tracer for the evaluation of ischaemic heart disease[9–14] and cardiomyopathies.[15–17] Regional discrepancies between the myocardial uptake of ^{123}I BMIPP and thallium-201 have been documented in ischaemic heart disease and in hypertrophic cardiomyopathy. However, little is known about the clinical significance of abnormalities of myocardial fatty acid metabolism in idiopathic dilated cardiomyopathy.

In the present study, we used ^{123}I BMIPP and thallium-201 SPECT to evaluate the distribution and extent of metabolic and perfusion abnormalities in patients with dilated cardiomyopathy, and examined the relation of these SPECT findings to clinicopathological variables and to the clinical course.

Methods

PATIENT POPULATION

We examined 32 consecutive patients with idiopathic dilated cardiomyopathy (24 men and eight women) ranging in age from 21 to 75 years (mean (SD) 52 (18) years) admitted between January 1994 and December 1995 to the National East Nagano Hospital for the evaluation of their cardiomyopathy. Criteria for enrolment in the study were a dilated (left ventricular end diastolic diameter > 55 mm), hypocontractile (ejection fraction < 45%) left ventricle, normal coronary arteries, and no evidence of specific cardiomyopathies such as valvar, hypertensive, or inflammatory cardiomyopathy. All patients underwent cross sectional and M mode echocardiography, coronary angiography, and right ventricular endomyocardial biopsy, as well as ^{123}I BMIPP

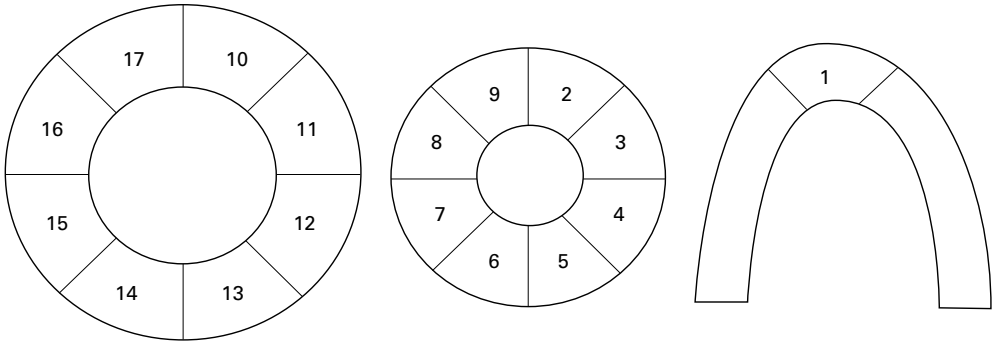

Figure 1 Segments used for SPECT data analysis. Anterior = segments 2, 9, 10, 17; lateral = segments 3, 4, 11, 12; inferior = segments 5, 6, 13, 14; septal = segments 7, 8, 15, 16; apical = 1.

and thallium-201 myocardial SPECT. New York Heart Association (NYHA) functional class was assessed at the time of the initial evaluation; five patients were in class I, 18 in class II, and nine in class III. ECG revealed atrial fibrillation in 11 patients and intraventricular conduction delay in 12. Sustained ventricular tachycardia was documented in two patients. Prospective observations were performed in all patients during a mean (SD) follow up of 20 (11) months, ranging from six to 32 months. The NYHA functional class, cardiothoracic ratio, and echocardiographic variables were assessed every six months in all patients.

SPECT IMAGING AND DATA ACQUISITION

^{123}I BMIPP containing 111 MBq (3 mCi) of iodine-123 labelled 15-(paraiodophenyl)-3(R,S)-methyl pentadecanoic acid (0.6 mg), dissolved in 10.5 mg of ursodeoxycholic acid as a solvent, was supplied by Nihon Medi-Physics Co (Nagoya, Japan). Both ^{123}I BMIPP and thallium-201 chloride (111 MBq (3 mCi)) were injected intravenously under resting conditions after at least four hours of fasting. The SPECT imaging was performed 20 minutes after the injection with a rotating gamma camera equipped with a low energy, general purpose collimator (GCA602A/SB; Toshiba, Tokyo, Japan), collecting 30 views over 180° from the right anterior to left posterior oblique positions, 30 seconds per view. The energy discrimination in the ^{123}I BMIPP SPECT was provided by a 20% window centred on the 159 KeV photopeak. All projection images were stored in a 64×64 word matrix. A GMS55U nuclear medical data processing device (Toshiba, Tokyo, Japan) was used. Transaxial images were reconstructed with filtered back-projection by a Shepp and Logan filter, after preprocessing projection images by a 5×5 smoothing filter. Vertical long axis and short axis slices were also generated. Neither attenuation correction nor scatter correction was performed. After ^{123}I BMIPP SPECT acquisition, each patient underwent thallium-201 SPECT on another day during a mean (SD) period of 9 (5) days (range 6 to 21 days). Thallium-201 SPECT images were obtained under the same acquisition conditions and reconstruction method as described above except that the energy discrimination was centred on the 80 KeV photopeak with a 20% window.

Table 1 Relation between total scores of ^{123}I BMIPP and thallium-201 and clinicopathological variables in patients with idiopathic dilated cardiomyopathy

	^{123}I BMIPP total score		*Thallium-201 total score*	
Cardiothoracic ratio	$r = 0.05$	$p = 0.791$	$r = 0.13$	$p = 0.515$
R wave voltage in lead V5	$r = -0.40$	$p = 0.033$	$r = -0.49$	$p = 0.007$
Echocardiography				
Left ventricular end diastolic diameter	$r = 0.17$	$p = 0.405$	$r = 0.29$	$p = 0.141$
Left ventricular end systolic diameter	$r = 0.20$	$p = 0.304$	$r = 0.29$	$p = 0.141$
% fractional shortening (initial)	$r = -0.25$	$p = 0.204$	$r = -0.14$	$p = 0.469$
% fractional shortening (6 month follow up)	$r = -0.58$	$p = 0.001$	$r = -0.39$	$p = 0.039$
Haemodynamics				
Left ventricular end diastolic pressure	$r = 0.65$	$p < 0.001$	$r = 0.36$	$p = 0.061$
Pulmonary capillary wedge pressure	$r = 0.68$	$p < 0.001$	$r = 0.42$	$p = 0.024$
Mean pulmonary arterial pressure	$r = 0.52$	$p = 0.004$	$r = 0.30$	$p = 0.119$
Cardiac index	$r = 0.24$	$p = 0.215$	$r = -0.26$	$p = 0.185$
Left ventricular ejection fraction	$r = -0.30$	$p = 0.121$	$r = -0.26$	$p = 0.185$
Histopathology				
Myocyte diameter	$r = 0.66$	$p < 0.001$	$r = 0.57$	$p = 0.001$
% area of interstitial fibrosis	$r = 0.69$	$p < 0.001$	$r = 0.53$	$p = 0.003$

Results of the linear regression analysis are presented.
See Methods for the definition of total score.
BMIPP, β-methyl-iodo-phenyl pentadecanoic acid.

SPECT DATA ANALYSIS

The segments used for the SPECT data analysis are shown in fig 1. The left ventricular myocardium was divided into 17 segments. The ^{123}I BMIPP and thallium-201 uptakes were scored semiquantitatively by two experienced observers with no previous knowledge of the clinical data, using a 4 point grading system for each segment (0 = normal, 1 = mildly reduced, 2 = moderately reduced, 3 = severely reduced or defective). When the ^{123}I BMIPP and thallium-201 scores were different, the segment was considered to be mismatched. Based on this grading system, mismatched segments were classified into one of the two following patterns: *type B mismatch*—segments showing a higher ^{123}I BMIPP than thallium-201 score; and *type T mismatch*—segments showing a higher thallium-201 than ^{123}I BMIPP score. A total score for all 17 segments was calculated for each patient. We used the ^{123}I BMIPP total score as an indicator of the severity of myocardial fatty acid metabolic abnormalities and the thallium-201 total score for myocardial perfusion abnormalities. We also assessed the score in each region—that is, the anterior territory in four segments, lateral in four, inferoposterior in four, septal in four, and apical in one.

ECHOCARDIOGRAPHY

Cross sectional and M mode echocardiography were performed during the initial evaluation and after six to 12 months of follow up using a

Table 2 Comparison of the initial clinicopathological data and drug treatment between the patients with deterioration and stable patients

	Deteriorated patients (n = 11)	*Stable patients (n = 21)*	*p Value*
New York Heart Association functional class (n (%))			
I	2 (18)	3 (14)	NS
II	6 (55)	12 (57)	NS
III	3 (27)	6 (29)	NS
IV	0 (0)	0 (0)	NS
Cardiothoracic ratio (%) (mean (SD))	54 (8)	57 (10)	NS
Echocardiography (mean (SD))			
Left ventricular end diastolic diameter (mm)	66 (9)	64 (9)	NS
Left ventricular end systolic diameter (mm)	57 (11)	54 (7)	NS
% fractional shortening (%)	16 (6)	16 (6)	NS
Haemodynamics (mean (SD))			
Left ventricular end diastolic pressure (mm Hg)	18 (8)	11 (6)	< 0.05
Pulmonary capillary wedge pressure (mm Hg)	16 (5)	11 (6)	< 0.05
Mean pulmonary arterial pressure (mm Hg)	24 (8)	19 (6)	NS
Cardiac index (l/min/m^2)	2.5 (0.5)	2.4 (0.4)	NS
Left ventricular ejection fraction (%)	30 (12)	31 (13)	NS
Electrocardiography			
Conduction disturbance (n (%))	8 (72)	4 (19)	< 0.01
Atrial fibrillation (n (%))	2 (18)	9 (43)	< 0.01
R wave voltage in lead V5 (mean (SD)) (mV)	13 (8)	22 (6)	< 0.01
Histopathology (mean (SD))			
Myocyte diameter (μm)	21 (3)	20 (5)	NS
Fibrosis (%)	13 (8)	9 (6)	NS
Drugs (n (%))			
Digitalis	8 (73)	18 (86)	NS
Diuretics	9 (82)	17 (81)	NS
Nitrate	7 (64)	10 (48)	NS
Angiotensin converting enzyme inhibitor	8 (73)	15 (71)	NS
β Blocker	0 (0)	2 (9)	NS

Unpaired *t* test or χ^2 test was used.

Toshiba SSH 160A. Cardiac dimensions were assessed from the M mode echocardiograms according to the criteria of the American Society of Echocardiography.[18]

CARDIAC CATHETERISATION AND ENDOMYOCARDIAL BIOPSY

All patients underwent right sided heart catheterisation, biplane left ventriculography, and coronary arteriography. None of the patients had significant narrowing (> 50%) of the luminal diameter of any major coronary artery. At the end of the cardiac catheterisation, a right ventricular endomyocardial biopsy was performed using a Cordis bioptome through the femoral vein. At least three biopsy specimens were obtained from the region of the interventricular septum.

Table 3 Comparison of the incidence, type, and distribution of mismatches between patients with deterioration and stable patients

	Deteriorated patients (n = 11)	*Stable patients (n = 21)*	*p Value*
Anterior segments (n = 128)	21/44 (48)	29/84 (35)	NS
Type B mismatching	14/44 (32)	14/84 (17)	< 0.05
Type T mismatching	7/44 (16)	15/84(18)	NS
Lateral segments (n = 128)	11/44 (25)	14/84 (17)	NS
Type B mismatching	6/44 (14)	9/84 (11)	NS
Type T mismatching	5/44 (11)	5/84 (6)	NS
Inferior segments (n = 128)	25/44 (57)	50/84 (60)	NS
Type B mismatching	15/44 (34)	26/84 (31)	NS
Type T mismatching	10/44 (23)	24/84 (29)	NS
Septal segments (n = 128)	26/44 (59)	17/84 (20)	< 0.001
Type B mismatching	17/44 (39)	6/84 (7)	< 0.001
Type T mismatching	9/44 (21)	11/84 (13)	NS
Apical segments (n = 32)	11/32 (34)	6/21 (28)	NS
Type B mismatching	3/11 (27)	3/21 (14)	NS
Type T mismatching	2/11 (18)	3/21 (14)	NS
Total segments (n = 544)	88/187 (47)	116/357 (32)	< 0.001
Type B mismatching	55/187 (29)	58/357 (16)	< 0.001
Type T mismatching	33/187 (18)	58/357 (16)	NS

Data are n (%) of segments. See Methods for definition of mismatching. The χ^2 test was used.

MYOCARDIAL TISSUE ANALYSIS

Myocardial tissue analysis was performed as described.[19 20] The tissue was initially fixed in 10% buffered formalin and subsequently embedded in paraffin for light microscopy. Using the specimens with Azan stain, interstitial fibrosis was evaluated with the point counting method. We used a lens with an 11×11 points square grid. The points of collagen fibres and of myocyte were counted in all observation areas by a pathologist without knowledge of the clinical findings, at a magnification of 400×. The ratio of the points of collagen fibres to the total counting points was used as the percentage fibrosis. Myocyte hypertrophy was also quantitatively analysed, using specimens with haematoxylin–eosin stain. At a magnification of 400×, the shortest distance across the nucleus was measured in at least 50 myocytes per specimen. The mean value of these measurements was determined as myocyte diameter.

STATISTICAL ANALYSIS

All continuous data were expressed as the mean (SD) and were compared by unpaired Student's *t* test. A paired *t* test was used to compare the changes in echocardiographic or radiographic measurements. Incidence was compared using the χ^2 test. The correlations of the total score obtained from the SPECT analysis with various clinical variables were examined by least squares linear regression analysis. The correlation coefficients are Pearson's *r* values. Probability (p) values of < 0.05 were considered statistically significant.

Results

SCINTIGRAPHIC FINDINGS AND CLINICOPATHOLOGY

Relation between the scintigraphic scores and clinicopathological variables

The data are given in table 1. The ^{123}I BMIPP total score was correlated with pulmonary capillary wedge pressure, left ventricular end diastolic pressure, and mean pulmonary arterial pressure, but the thallium-201 score was only correlated with pulmonary capillary wedge pressure. Although neither the thallium-201 nor ^{123}I BMIPP total scores were correlated with any of the initial echocardiographic variables, the cardiothoracic ratio, cardiac index, or left ventricular ejection fraction, the percentage fractional shortening recorded at the six month follow up was strongly correlated with the ^{123}I BMIPP total score. The ^{123}I BMIPP score showed a close correlation with both myocyte diameter and percentage area of interstitial fibrosis measured by morphometry in the biopsy specimens. The thallium-201 score also showed significant correlations with these histological indices.

Mismatching between thallium-201 and ^{123}I BMIPP myocardial uptake

Mismatches were observed in 204 of the 544 segments (37%). Of the 204 mismatched segments, there was type B mismatching in 113 segments (21%) and type T mismatching in 91

Table 4 Comparison of the total and regional scores between the patients with deterioration and stable patients

	^{123}I BMIPP		Thallium-201	
	Deteriorated patients (n = 11)	*Stable patients (n = 21)*	*Deteriorated patients (n = 11)*	*Stable patients (n = 21)*
Total region	20.0 (7.2)	14.5 (8.1)	17.6 (5.7)	15.1 (7.6)
Anterior region	4.5 (3.2)	3.3 (3.1)	3.8 (3.3)	3.6 (3.2)
Lateral region	2.3 (3.4)	1.8 (3.0)	1.8 (2.6)	1.6 (3.0)
Inferior region	7.2 (1.5)	6.2 (3.5)	6.0 (2.5)	6.4 (3.2)
Septal region	5.2 (3.5)	2.3 (2.5)*	4.3 (3.7)	2.8 (2.6)
Apical region	2.0 (1.9)	1.4 (1.5)	1.4 (2.0)	1.6 (1.7)

Data are mean (SD).
*p < 0.01; unpaired *t* test.
BMIPP, β-methyl-iodo-phenyl pentadecanoic acid.

segments (16%). These mismatches occurred more commonly in the inferoposterior segments (75/128; 59%) than in the lateral segments (25/128; 20%, p < 0.05).

CLINICAL COURSE AND PROGNOSTIC INDICATORS

Clinical course and changes in cardiothoracic ratio and percentage fractional shortening

A deterioration in NYHA functional class was observed in 11 of the 32 patients during the 6 to 12 month follow up period, and four of the 11 died of congestive heart failure. Treatment with β blockers was started in four of the remaining seven patients, and these patients achieved clinical stability. The cardiothoracic ratio in the deteriorated patients increased during the first six months of follow up, from 54 (8)% to 58 (9)% (p < 0.001), but not in the stable patients (56 (12)% to 57 (12)%). Percentage fractional shortening in the deteriorated patients decreased during follow up from 16 (6)% to 12 (5)% (p = 0.004), while in the stable patients it increased from 15 (5)% to 19 (5)% (p = 0.008).

Prognostic significance of the clinicopathological findings

A comparison of the initial clinical indices and pathological data between the deteriorated patients and those with a stable clinical course is given in table 2. Left ventricular end diastolic pressure and pulmonary capillary wedge pressure were significantly greater in the deteriorated patients. Intraventricular conduction delay was more often observed in the deteriorated patients (right bundle branch block in four and left bundle branch block in four) than in the stable patients (p < 0.01). In contrast, atrial fibrillation was more often documented in the stable patients (p < 0.05). The R wave voltage in lead V5 in the stable patients was significantly greater than that observed in the deteriorated patients (p < 0.01). Treatment was similar between the two groups except that two patients in the stable group were treated with β blockers because of ventricular arrhythmias.

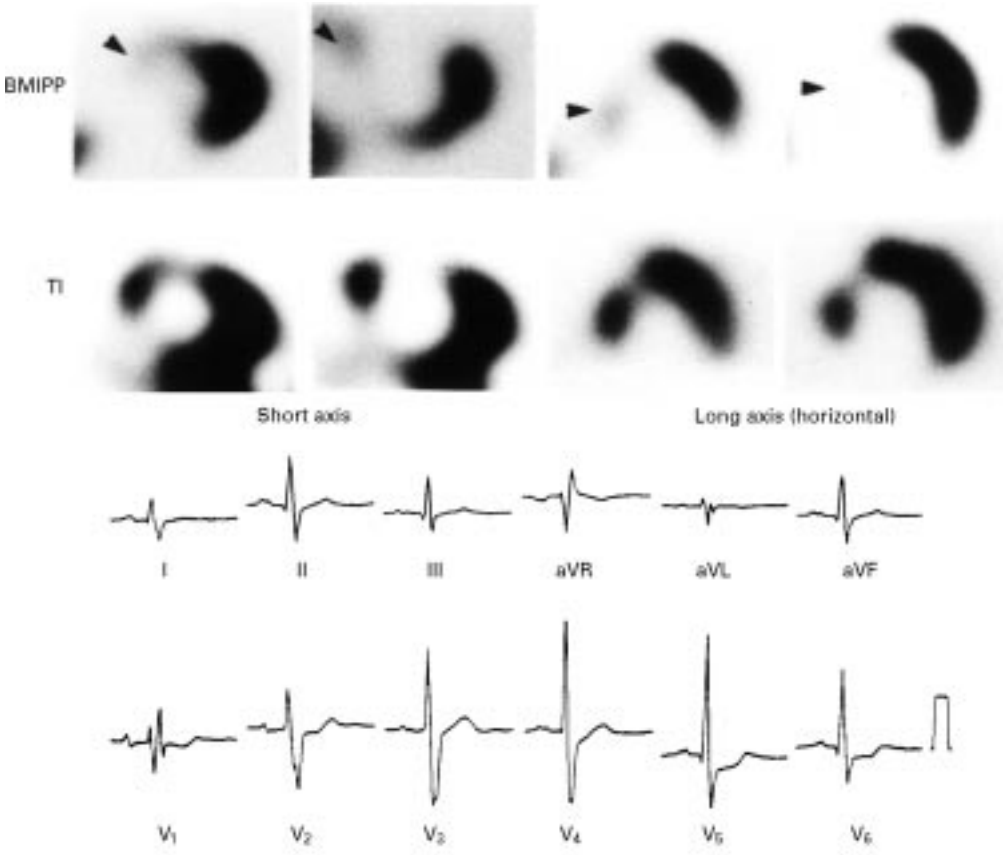

Figure 2 A representative case of type B mismatching in the interventricular septum. A 64 year old female patient showed complete right bundle branch block. Short axis and horizontal images with ^{123}I BMIPP and thallium-201 SPECT show type B mismatching in the intraventricular septum (arrowheads). Since this patient showed a decrease in exercise capacity and an increase in the cardiothoracic ratio from 52% to 57% during the follow up period, treatment with β blockade was begun.

Prognostic significance of scintigraphic findings
A comparison of ^{123}I BMIPP and thallium-201 scintigraphic findings between the deteriorated and stable patients is given in table 3. Mismatches (type B and T) in the patients who had deteriorated were detected in 88 of the 187 segments—type B mismatches in 55 segments (30%), and type T mismatches in 33 segments (18%). The incidence of type B mismatches in the deteriorated patients was greater than in the stable patients in all regions combined ($p < 0.001$), and in the anterior ($p < 0.05$) and septal ($p < 0.001$) areas. A comparison of the regional and total scores is given in table 4. In the interventricular septum, the ^{123}I BMIPP scores in the deteriorated patients were greater than those in the stable patients ($p < 0.01$). In addition, the scores in the interventricular septum showed a close correlation with the total score for both ^{123}I BMIPP ($r = 0.66$, $p < 0.001$) and thallium-201 ($r = 0.70$, $p < 0.001$). A representative case is illustrated in fig 2.

Discussion

To our knowledge, this is the first study analysing the correlations of fatty acid metabolic abnormalities with clinicopathological findings and clinical course using ^{123}I BMIPP SPECT.

IMPAIRED FATTY ACID METABOLISM IN DILATED CARDIOMYOPATHY

The myocardial uptake of ^{123}I BMIPP is influenced by regional myocardial blood flow, a decreased triglyceride pool, reduced intracellular concentrations of ATP, or loss of myocytes.[6–8] The kinetics of this tracer in idiopathic dilated cardiomyopathy remain unknown. To date there have been three reports[21–23] on abnormalities of myocardial fatty acid metabolism in patients with idiopathic dilated cardiomyopathy detected by C-11 palmitate positron emission tomography or SPECT using other synthetic fatty acids labelled with iodine-123. In these nuclear studies the tracers C-11 palmitate, iodine-123 heptadecanoic acid, and phenylpentadecanoic acid have shown a varied degree of myocardial activity in patients with dilated cardiomyopathy of various aetiologies. Rapid washout of the last was also detected.[23] ^{123}I BMIPP, which has a long retention time in the myocardium, provides high quality SPECT images and has become widely available for clinical use.

In our study, most of the patients had various degrees of heterogeneous ^{123}I BMIPP myocardial uptake or segmental defects, despite normal coronary angiograms. One of the most important findings was the close correlation between the extent of the abnormalities of fatty acid metabolism and the severity of the haemodynamic and histopathological indices. Since right ventricular biopsy samples are usually obtained from the interventricular septum, the histological features of these specimens can reflect scintigraphic changes at this site. Furthermore, the interventricular septum score was correlated with the total score with both thallium-201 and ^{123}I BMIPP imaging. Therefore, the relation we showed between the scintigraphic findings and the histopathology appears to be valid. However, it is possible that the scintigraphic data and the histological and haemodynamic abnormalities are heterogeneous because of differences in the site of data acquisition. Impaired fatty acid metabolism is probably related to the pathophysiology and processes of myocardial damage in patients with idiopathic dilated cardiomyopathy.

MISMATCHING BETWEEN MYOCARDIAL FATTY ACID METABOLISM AND PERFUSION

Discrepancies between the images obtained with fatty acid analogues and flow tracers such as thallium-201 or technetium-99m Sestamibi distribution have been reported in ischaemic heart disease.[9–14] According to a report by Tamaki *et al*,[9] using thallium-201 as a flow tracer, type B mismatching was observed more often in acute than in chronic myocardial infarction, and in successfully reperfused as opposed to unsuccessfully reperfused segments. The type B mismatching may represent the delayed recovery of fatty acid metabolism after reperfusion in subacute myocardial infarction, and ischaemic but viable myocardium in chronic coronary artery disease. This discrepancy is also frequently observed in patients with hypertrophic cardiomyopathy, and is seen especially in the hypertrophic myocardium.[15–17]

In idiopathic dilated cardiomyopathy, the clinical significance of such mismatching has not been discussed. In this study, most of our patients showed some degree of type B mismatching. This is in agreement with the previously reported finding that regions of decreased C-11 palmitate uptake in the myocardium were discordant with those of decreased myocardial perfusion by thallium-201 imaging in congestive cardiomyopathy.[21] Interestingly, type T mismatching was observed in 43% of the mismatched segments in our cardiomyopathy patients. The influence of artefacts may be considered as a cause of type T mismatching. Because of the higher energy level of ^{123}I compared with thallium-201, the effect of soft tissue attenuation is decreased and myocardial uptake is more clearly visualised in ^{123}I BMIPP scanning than thallium-201 scanning. However, this is unlikely to be the major cause of type T mismatching, since it has been reported rarely in other heart diseases, including ischaemic heart disease and hypertrophic cardiomyopathy.[9–17] Further studies are needed.

CLINICAL IMPLICATIONS

The natural history and prognostic factors of idiopathic dilated cardiomyopathy have been discussed.[24–27] However, the outcome varies from study to study. The recent use of angiotensin converting enzyme (ACE) inhibitors and β blockers for congestive heart failure has altered the prognostic importance of individual factors.[27–29] In the present study, the severity of the abnormalities of fatty acid metabolism showed a close correlation with the percentage fractional shortening at the six month follow up, but no correlation with systolic function at the initial evaluation. We also analysed the relation between uptake of

the two tracers among the myocardial regions and the clinical course in idiopathic dilated cardiomyopathy. Type B mismatching was often observed in patients with a poor prognosis. According to segmental analysis, type B mismatching in the septal and anterior wall was related to clinical deterioration. However, mismatching in the inferoposterior regions occurred most commonly but was not related to the clinical course. This discrepancy may be because the incidence of mismatching in the inferoposterior region is strongly influenced by the different diaphragmatic attenuation between the two isotopes.

These results indicate that preserved myocardial fatty acid metabolism in patients with idiopathic dilated cardiomyopathy predicts the improvement of systolic function and a stable clinical course, and that patients with type B mismatch in the anteroseptal regions require careful observation and intensive treatment including ACE inhibitors and β blockers. Furthermore, the impairment of myocardial fatty acid metabolism in patients showing deterioration was prominent in the interventricular septum, and most of these patients had ECG evidence of septal abnormality. Therefore, a marked abnormality of fatty acid metabolism in the interventricular septum may be related to intraventricular conduction delay.

LIMITATIONS OF THE STUDY

There are several limitations in this study. First, we could not evaluate the absolute myocardial uptake of ^{123}I BMIPP. The application of quantitative methods would provide new information about idiopathic dilated cardiomyopathy. Visual analysis by SPECT is, however, considered to be suitable for the comparison of the regional uptake between the two tracers. Second, since ^{123}I BMIPP is resistant to β oxidation, it will not provide complete information about myocardial fatty acid metabolism. Tamaki *et al* showed that the myocardial uptake of ^{123}I BMIPP paralleled that of palmitic acid.[10] Therefore, the ^{123}I BMIPP uptake is thought to reflect some metabolic conditions and seems to be an acceptable way of assessing the metabolic abnormalities. Finally, serial changes in these scintigraphic findings could not be examined in this study. The number of our patients was relatively small, and their mean age was rather high. Therefore, our results must be treated with caution. Further case experience, particularly in a younger population of idiopathic dilated cardiomyopathy, and long term follow up are required.

CONCLUSIONS

^{123}I BMIPP SPECT provides new information about the relation between impaired fatty acid metabolism and clinicopathological findings in idiopathic dilated cardiomyopathy. The extent of the abnormalities of myocardial fatty acid metabolism strongly reflects the severity of the haemodynamic and histopathological abnormalities, and more accurately predicts changes in systolic performance than tests of perfusion abnormality. The SPECT mismatching, with a lower ^{123}I BMIPP than thallium-201 uptake—in addition to increased left ventricular filling pressure, decreased R wave voltage in lead V5, and intraventricular conduction delay—may be a good indicator of the short term prognosis in patients with idiopathic dilated cardiomyopathy. Therefore, combined imaging with ^{123}I BMIPP and thallium-201 may be useful in the management of patients with this condition.

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