Regional Metabolic Abnormality in Relation to Perfusion and Wall Motion in Patients with Myocardial Infarction: Assessment with Emission Tomography Using an Iodinated Branched Fatty Acid Analog

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The clinical usefulness of single-photon tomography using both a beta-methyl-branched fatty acid analog, ^{123}I-15-(p-iodophenyl)-3-methyl pentadecanoic acid (BMIPP) and ^{201}Tl was assessed in 4 normal subjects and 28 patients with myocardial infarction. A homogeneous distribution of the tracer in the left ventricular myocardium was observed in each normal subject. BMIPP uptake was decreased compared to ^{201}Tl (discordant) in 17/28 patients (61%) and in 49/196 myocardial segments (25%). Such discordant BMIPP uptake was observed more often in areas of acute myocardial infarction (59% at ≤4 wk versus 31% at >4 wk after onset) ($p < 0.01$) and areas supplied with revascularized arteries (74% for revascularized versus 28% for nonrevascularized areas) ($p < 0.01$). In addition, the discordant BMIPP uptake was seen more often in the segments exhibiting a wall motion score lower than the perfusion score (46%) in comparison to segments showing a similar decrease in both the wall motion and perfusion scores (12%) ($p < 0.01$). Thus, BMIPP imaging may play a major role in increasing our understanding of the relationship between perfusion and wall motion, particularly in patients with acute myocardial infarction and those who received revascularization therapy.

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Since fatty acids play a major role as energy sources for the normal myocardium (*1,2*), efforts have been made to label fatty acids or their analogs in order to probe regional myocardial metabolism using positron emission tomography (PET) and single-photon emission computed tomography (SPECT). PET with ^{11}C palmitate has shown great promise in assessing fatty acid metabolism in patients with ischemic heart disease in vivo (*3–7*). To facilitate such studies of fatty acid metabolism using SPECT, various iodinated fatty acid analogs have been introduced (*8–12*).

Radioiodinated straight-chain fatty acids are cleared from the myocardium reflecting oxidation of fatty acid (*13,14*), while methyl-branched fatty acid analogs are trapped in the myocardium (*15,16*). Therefore, the latter may be suitable for SPECT imaging because of their prolonged residence time in the myocardium. However, the uptake mechanism of such branched fatty acids should be clarified (*17–20*). We recently reported that myocardial accumulation of radioiodinated-15-iodophenyl 3-methyl pentadecanoic acid (BMIPP) correlated well with intracellular adenosine triphosphate (ATP) content (*21*).

To clarify the clinical significance of this tracer for assessing ischemic heart disease, ^{123}I-labeled BMIPP imaging was performed in patients with myocardial infarction for a comparison with ^{201}Tl perfusion and regional wall motion by contrast ventriculography.

MATERIALS AND METHODS

Patients

Four normal subjects and 28 patients with myocardial infarction underwent SPECT imaging using BMIPP at rest. The four normal subjects included three normal volunteers who had less than 1% probability of coronary artery disease for their age group, electrocardiographic (ECG) findings and clinical histories. The fourth subject had nonanginal chest pain but showed no significant coronary stenosis on angiogram. For the 28 patients with myocardial infarction [23 men, 5 women, ranging in age from 29 to 75 yr (mean 59.2 yr)], the diagnosis was made based on a history of acute myocardial infarction by elevation of cardiac enzymes, typical precordial symptoms and Q-waves on their ECGs. The interval from the most recent onset of infarction ranged from 10 days to 8 yr (mean: 14.0 mo). All patients had coronary angiography. Four patients had undergone successful

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percutaneous transluminal coronary angioplasty (PTCA), and six patients had received intracoronary thrombolysis. Successful revascularization was proved by a follow-up angiogram before the BMIPP study. All subjects gave written informed consent based on the guidelines of the hospital's Human Clinical Study Committee.

Twenty-five patients, including one normal subject, underwent coronary arteriography and contrast ventriculography within 2 wk of the radionuclide study. The remaining four patients underwent angiography within 4 wk of the radionuclide study.

Radiopharmaceuticals

Iodine-123 BMIPP, a beta-methyl-branched fatty acid analog, was prepared and supplied by Nihon Medi-Physics Company. BMIPP contained 3 mCi (111 MBq) of ^{123}I-labeled 15-(para-iodophenyl)-3(R,S)-methyl pentadecanoic acid (0.6 mg) dissolved in 10.5 mg of urso-deoxycholic acid as a solvent (which did not affect the distribution of BMIPP in animal studies).

Protocol

Twenty-nine patients underwent BMIPP and ^{201}Tl SPECT imaging at rest using a rotating gamma camera equipped with a low-energy, general-purpose collimator (Starcam: General Electric: Milwaukee, WI). Three millicuries (111 MBq) of BMIPP were injected at rest in a fasting state approximately 3–5 hr after a meal. SPECT imaging was started 30 min later, at which time 32 views over 180° from the right anterior oblique (RAO) to the left posterior oblique (LPO) positions at 30–40 sec/view were collected. Thallium-201 SPECT was performed within 1 wk of the BMIPP study in patients with acute myocardial infarction (interval from onset ≤4 wk) and within 2 wk in the remaining patients. Ten to 15 min after injection of 2.7–3.5 mCi (100–130 MBq) ^{201}Tl-chloride at rest, SPECT imaging was performed and 32 views of 30 sec each were collected as previously described (*22–24*). For the three normal volunteers, only BMIPP SPECT imaging was performed.

In each SPECT study, a series of transaxial images were reconstructed using filtered backprojection, after which cardiac short-axis and long-axis slices perpendicular to the cardiac axes were reorganized.

Image Analysis

BMIPP and ^{201}Tl SPECT images were read separately and blindly to analyze the differences in tracer distributions in the left ventricular myocardium. The left ventricular myocardium was divided into seven segments (anterobasal, anterior, apical, inferior, posterobasal, septal and lateral) to score BMIPP and ^{201}Tl uptakes in each segment with the consensus of two experienced observers using a four-point grading system (3 = normal, 2 = mildly reduced; 1 = moderately reduced and 0 = absent). The agreement rate between the two observers was 87% (170/196 segments) for the BMIPP images and 91% (178/196) for the ^{201}Tl images. When the score in each segment was different for both tracers, the segment was considered to show discordant uptake. When the score was the same, the segment was considered to show concordant uptake.

For quantitative analysis of the tracer distributions, the circumferential profile curve was generated from apical to basal short-axis slices to create a bull's-eye polar map of 100% as a maximum count in each ^{201}Tl and BMIPP distributions (*25*). When the mean counts (%count) of ^{201}Tl and BMIPP in individual segments differed by 10% or more, tracer distribution was considered discordant, whereas distribution was considered concordant when the mean counts differed less than 10%. When the difference in distribution was equivocal on visual analysis, these quantitative criteria were used.

Regional Wall Motion Analysis

Contrast ventriculography in the right and left anterior oblique projections was performed for each subject to assess regional wall motion at rest. Three experienced observers scored regional wall motion in the seven myocardial segments by consensus using a five-point grading system (3 = normal; 2 = hypokinesis; 1 = severe hypokinesis, 0 = akinesis and −1 = dyskinesis).

Statistical Analysis

Chi-square analysis or Fisher's exact test was used to determine differences between the proportions of concordance and discordance of the BMIPP and ^{201}Tl uptake scores. Wall motion scores were expressed as mean ± standard deviation. Differences in the wall motion score in each subgroup were compared using analysis of variance. Probability values of less than 0.05 were considered to be significant.

RESULTS

Discrepancy

Homogeneous distribution of BMIPP was observed in the four normal subjects. Since the ^{123}I-BMIPP had a higher energy photon than ^{201}Tl, the BMIPP activity in the septal and inferior wall seems to be slightly higher than that of ^{201}Tl (Fig. 1). The difference in the distribution of these tracers on the polar map was 8.2% in the septal region and <7% in the remaining segments.

Of the 28 patients with myocardial infarction, 11 patients showed similar (concordant) distribution of these tracers in all segments (Fig. 2), whereas the remaining 17 patients showed less BMIPP uptake than ^{201}Tl (discordant) in at least one myocardial segment (Figs. 3–4). In each patient showing discordant BMIPP uptake, the regional BMIPP uptake was less than the ^{201}Tl uptake. There were no patients showing higher BMIPP uptake compared to the ^{201}Tl uptake.

Of the 196 total segments, 147 segments (75%) showed the same scores for BMIPP and ^{201}Tl uptake, indicating concordant distribution. However, the remaining 49 segments (25%) showed a lower BMIPP uptake score than ^{201}Tl score (Table 1). There were no segments showing a BMIPP score higher than a ^{201}Tl score.

Relationship to Interval from Infarction

When these patients were grouped as those with acute myocardial infarction with an interval from infarct of 4 wk or less and those with chronic myocardial infarction with an interval from infarct of more than 4 wk, discordant BMIPP uptake was observed in 9 of 13 patients with acute infarction (69%) and in 7 of 15 patients with chronic infarction (47%).

Of 113 abnormal segments with either ^{201}Tl or BMIPP scores of less than 3, 49 segments (43%) showed less BMIPP uptake than ^{201}Tl (discordant), and the remaining

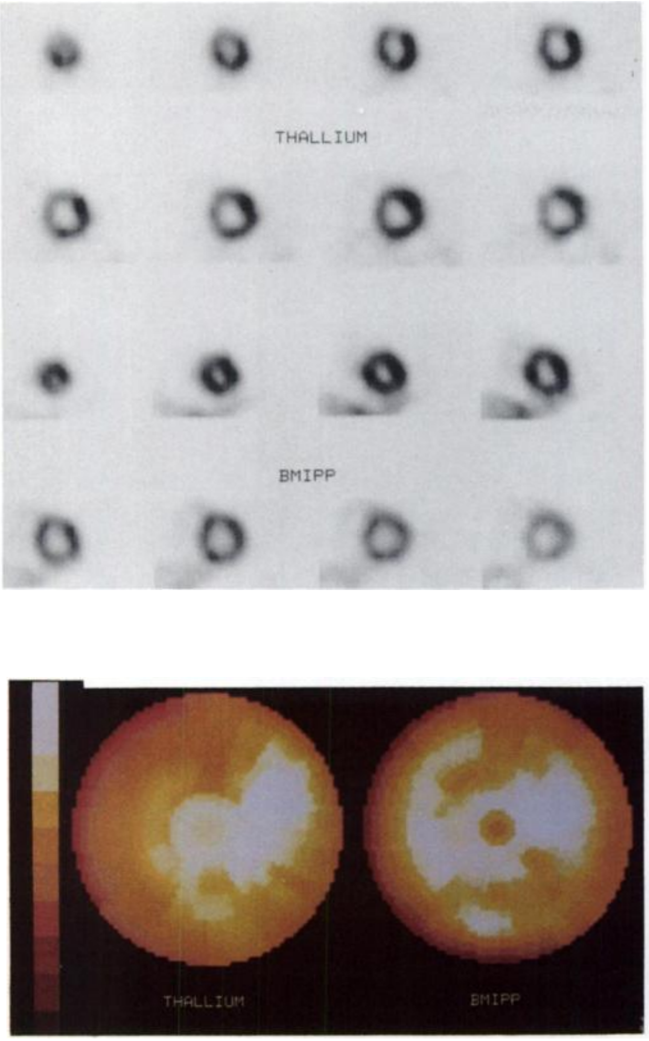

FIGURE 1. (Top) A series of short-axis slices of ^{201}Tl images and BMIPP images for a female patient with normal coronary arteries on angiogram. Homogeneous distributions of ^{201}Tl and BMIPP are noted in the left ventricular myocardium, although ^{201}Tl uptake in the septal wall looks slightly lower, probably due to greater photon attenuation of ^{201}Tl. (Bottom) Bull's-eye polar maps of ^{201}Tl and BMIPP distribution. Thallium-201 uptake in the septal region was lower than that of BMIPP (difference was 8.2%).

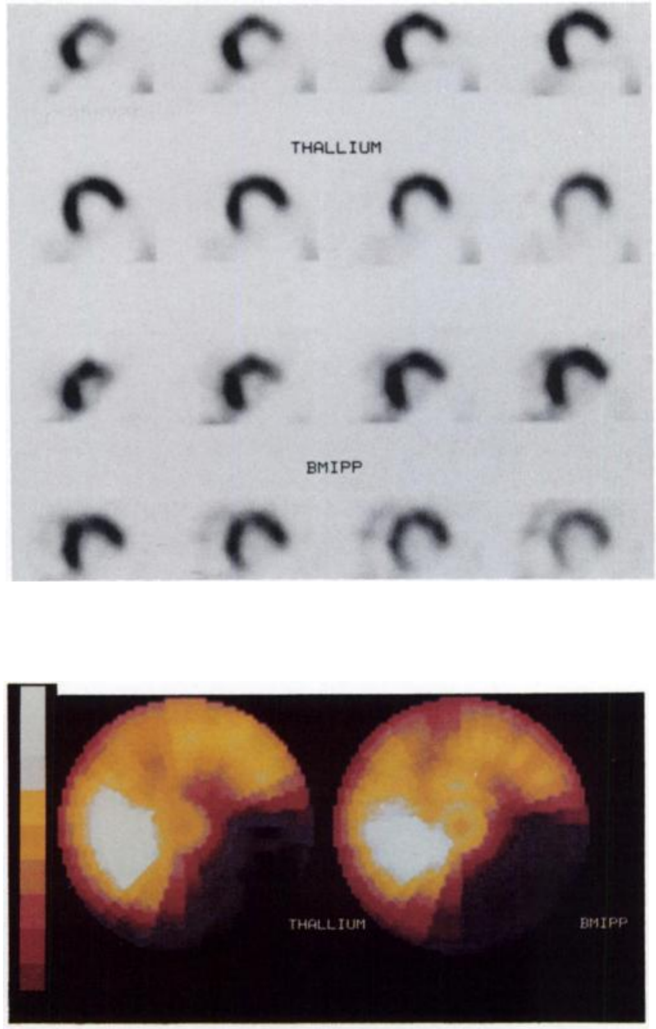

FIGURE 2. (Top) A series of short-axis slices of ^{201}Tl images and BMIPP images for a patient with inferior wall myocardial infarction. A large perfusion defect is observed in the inferior and lateral regions in resting ^{201}Tl images. The distribution of BMIPP is similar to that of ^{201}Tl, without any discordant distribution. (Bottom) Bull's-eye polar maps of ^{201}Tl ann BMIPP distribution. The distribution of these tracers is similar.

64 segments (57%) showed a similar decrease in BMIPP and ^{201}Tl uptake (concordant). Discordant BMIPP uptake was observed in 29 of 49 segments of patients with myocardial infarction (59%) within 4 wk, while discordant uptake was seen in only 20 of 64 segments of patients with chronic infarction (31%) ($p < 0.01$) (Table 2).

Relationship to Revascularization

Ten patients were successfully revascularized in the acute stage of myocardial infarction by PTCA or intracoronary thrombolysis. Eight of them (80%) showed discordant BMIPP uptake in at least one myocardial segment, whereas 9 of 18 patients (50%) without revascularization showed discordant BMIPP uptake. Of 113 abnormal segments, 28 of 38 segments (74%) supplied by revascularized arteries showed discordant BMIPP uptake, whereas only 21 of 75 segments (28%) without successful revascularization showed discordant BMIPP uptake ($p < 0.01$) (Table 3). When the patients with acute infarction were selected for analysis, 73% of the revascularized segments showed discordant BMIPP uptake, whereas 43% of the nonrevascularized segments showed the discordance (Table 3).

Relationship to Regional Wall Motion

The BMIPP uptake score correlated well with the regional wall motion score ($r = 0.70$) ($p < 0.01$) (Table 4). When the patients with acute infarction were selected for analysis, a high correlation ($r = 0.76$) ($p < 0.01$) was obtained between the BMIPP uptake and regional wall motion scores (Table 5). Table 6 shows the correlation of

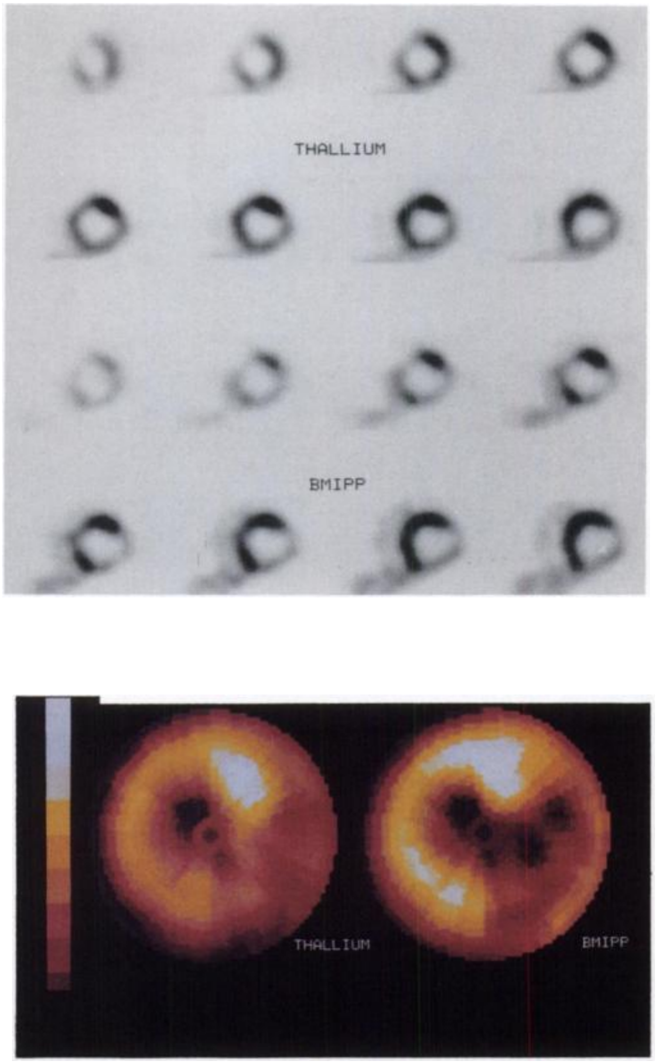

FIGURE 3. (Top) A series of short-axis slices of ^{201}Tl images and BMIPP images of a patient with acute (2.5 wk after onset) inferior and prior (1 yr after onset) anterior wall myocardial infarction. A concordant decrease in BMIPP and ^{201}Tl uptake is observed in the anterior regions. BMIPP uptake, however, is severely reduced in the inferior and lateral regions, where ^{201}Tl uptake is only slightly reduced (discordant). (Bottom) Bull's-eye polar maps of ^{201}Tl and BMIPP distribution. The distribution in the anterior and apical regions is similar, but the BMIPP uptake in inferior and lateral regions is lower than ^{201}Tl (discordant).

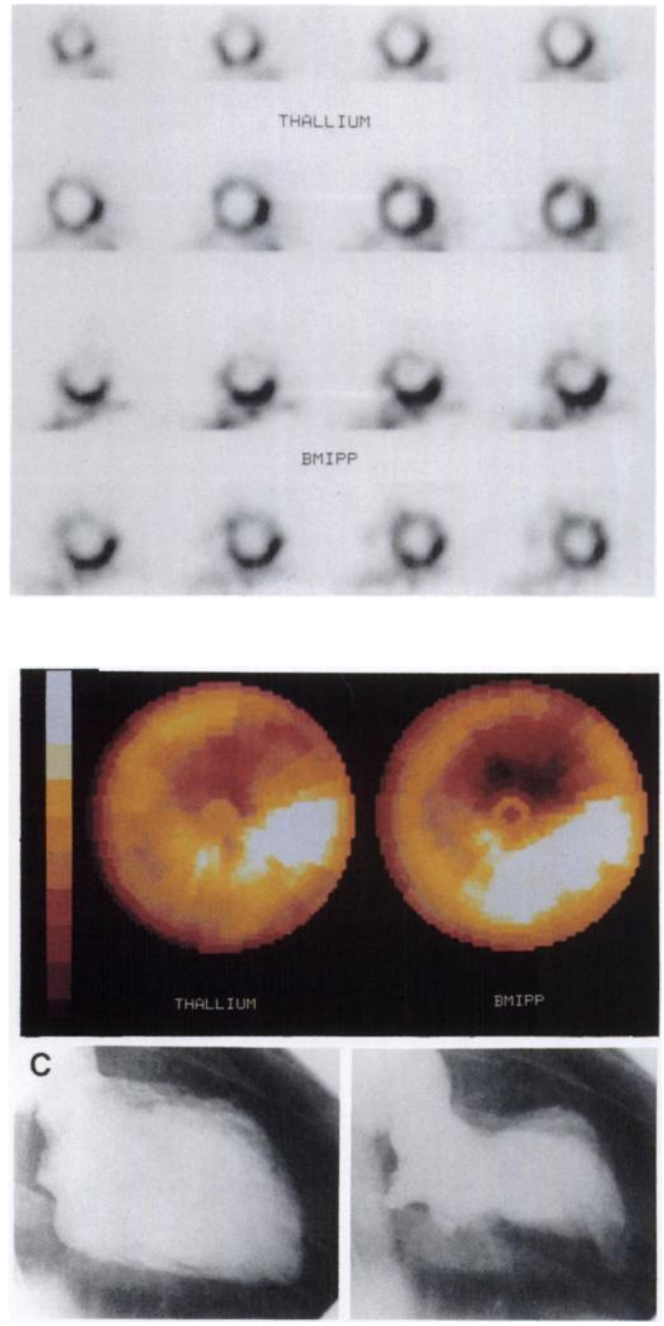

FIGURE 4. (Top) A series of short-axis slices of ^{201}Tl images and BMIPP images of a patient with acute (2 wk) anterior wall myocardial infarction who was treated by intracoronary thrombolysis on admission. BMIPP uptake is severely reduced in the apical and anterior regions, where ^{201}Tl uptake is only slightly reduced (discordant). (Middle) Bull's-eye polar map of ^{201}Tl and BMIPP distributions. BMIPP uptake in anterior region is lower than ^{201}Tl (discordant). (Bottom) Contrast ventriculograms at end-diastole (left) and end-systole (right) in the right anterior oblique projection show akinetic wall motion in the apical and anterior regions.

the ^{201}Tl uptake score with the regional wall motion score ($r = 0.70$) ($p < 0.01$). In the study of patients with acute infarction, a high correlation ($r = 0.72$) ($p < 0.01$) was also observed between the two groups (Table 7).

These two scores were matched in 109 segments (group 1) (Table 8). The wall motion score was higher than the ^{201}Tl score in 33 segments (Group 2), while it was lower in 54 segments (Group 3). Discordant BMIPP uptake was observed only in 13 segments in Group 1 (12%), whereas it was seen in 11 segments in Group 2 (33%) ($p < 0.05$ versus Group 1) and 25 segments in Group 3 (46%) ($p < 0.01$ versus Group 1) (Table 8). When a similar analysis was performed in patients with acute infarction, this tendency was more striking (Table 9). Discordant BMIPP uptake was observed only in 5 of the 47 segments in Group 1 (11%), whereas it was seen in 5 of the 10

TABLE 1
Relationship of BMIPP and ^{201}Tl Uptake Scores in the Total of Myocardial Segments

	BMIPP score				
Thallium score	3	2	1	0	Total
3	83	6	4	0	93
2	0	16	20	4	40
1	0	0	22	15	37
0	0	0	0	26	26
Total	83	22	46	45	196

3 = normal; 2 = mildly reduced; 1 = moderately reduced; and 0 = defect.

TABLE 3
BMIPP and ^{201}Tl Findings in Hypoperfused Segments in Patients with and without Revascularization in Acute Stages of Infarction

	Successful revascularization		
BMIPP/Tl findings	+	−	Total
BMIPP = Tl	10 (7)	54 (13)	64 (20)
BMIPP < Tl	28 (19)	21 (10)	49 (29)
Total	38 (26)	75 (23)	113 (49) ($p < 0.01$)

Figures in parentheses denote the number of segments in patients with acute myocardial infarction.

segments in Group 2 (50%) and 19 of 34 segments in Group 3 ($p < 0.01$ each versus Group 1) (Table 9).

Of 113 abnormal segments, the mean wall motion score on contrast ventriculography was similar in segments exhibiting discordant BMIPP uptake (0.78 ± 1.31) and concordant BMIPP uptake (0.87 ± 1.47, p = ns). However, when the segments with the same ^{201}Tl uptake score were selected for analysis, the segments showing discordant BMIPP had a lower wall motion more than those with concordant BMIPP uptake for the same ^{201}Tl uptake score (^{201}Tl score = 2 and 3) (Fig. 5). Thus, in the areas showing a similar level of hypoperfusion, wall motion was significantly reduced in the areas showing discordant BMIPP uptake compared to the areas showing concordant BMIPP uptake.

DISCUSSION

This study shows that BMIPP was accumulated in the left ventricular myocardium, but the relative concentration in segments with schemic injury was often less than that of ^{201}Tl. The BMIPP uptake score was related to the severity of the regional wall motion abnormality. More importantly, a discordant decrease in BMIPP was frequently seen in areas showing a regional wall motion abnormality with relatively preserved perfusion. Thus, the discordant decrease in BMIPP uptake may indicate a persistent metabolic abnormality associated with the failure of functional recovery after revascularization, particularly in patients with acute myocardial infarction.

Technical Considerations

Since free-fatty acids are major energy sources in the normal myocardium, many attempts have been made to assess regional fatty acid metabolism with PET and ^{11}C-palmitate and SPECT and various iodinated fatty acid compounds (*3–14*). Most of these studies included clearance kinetic study of straight-chain fatty acid tracers from the myocardium to assess beta-oxidation of fatty acids. Iodine-123-iodophenyl pentadecanoic acid (IPPA) has been investigated in patients with ischemic heart disease (*26–29*). These studies indicated a heterogeneous distribution of IPPA different from that of ^{201}Tl perfusion. However, since incorporated IPPA was cleared from the myocardium over time, the IPPA and ^{201}Tl findings may become inconsistent, particularly when studies are recorded with SPECT using a rotating gamma camera, where at least 15–20 min are required for one set of images. To eliminate this technical problem, a methyl-branched fatty acid analog, BMIPP, has been developed (*11–12*). The improved extraction and prolonged residence time of modified fatty acid analogs are desirable for SPECT imaging. In this study, excellent SPECT images were obtained with

TABLE 2
BMIPP and ^{201}Tl Findings in Abnormal Segments in Relation to Interval from Onset of Myocardial Infarction

BMIPP/Tl findings	≤4wk	>4wk	
BMIPP = Tl	20	44	64
BMIPP < Tl	29	20	49
Total	49	64	113 ($p < 0.01$)

TABLE 4
BMIPP Uptake Scores in Relation to Wall Motion Scores in 196 Segments

	Wall motion score				
BMIPP score	3	2	1	0/−1	Total
3	66	16	0	1	83
2	11	5	2	4	22
1	11	11	7	17	46
0	4	4	6	31	45
Total	92	36	15	53	196

TABLE 5
BMIPP Uptake Scores in Relation to Wall Motion Scores in Patients with Acute Myocardial Infarction

	Wall motion score				
BMIPP score	3	2	1	0/−1	Total
3	32	9	0	1	42
2	6	0	1	2	9
1	2	3	3	10	18
0	1	2	2	17	22
Total	41	14	6	30	91

TABLE 7
Thallium-201 Uptake Scores in Relation to Wall Motion Scores in Patients with Acute Myocardial Infarction

	Wall motion score				
Thallium score	3	2	1	0/−1	Total
3	34 (2)	9 (0)	0 (0)	3 (2)	46 (4)
2	6 (2)	3 (3)	2 (1)	8 (8)	19 (14)
1	1 (1)	2 (2)	3 (0)	12 (8)	18 (11)
0	0 (0)	0 (0)	1 (0)	7 (0)	8 (0)
Total	41 (5)	14 (5)	6 (1)	30 (18)	91 (29)

Figures in parentheses denote the number of segments exhibiting discordant BMIPP uptake.

a rotating gamma camera. However, the mechanism for retention of this tracer in the myocardium needs to be clarified. In addition, since its distribution is greatly influenced by regional myocardial blood flow, a combined assessment of the distribution of BMIPP and ^{201}Tl should be performed.

Since the photon energy of ^{123}I is higher (159 keV) than that of ^{201}Tl (69–80 keV), the attenuation of ^{123}I tracers in the body is substantially lower than that of ^{201}Tl. Thus, the distribution of BMIPP in septal and inferior regions looked higher than that of ^{201}Tl, as indicated in Figure 1. BMIPP and ^{201}Tl should be compared carefully to avoid misinterpretation based on this physical characteristic. For objective analysis of the distribution, a bull's-eye polar display was used. When the difference of the distribution was equivocal with visual analysis, this quantitative analysis was used. Distribution was considered discordant when differences in distribution were 10% or greater on this map.

Potential Uptake Mechanisms

Methyl branching of a fatty acid is thought to provide protection against metabolism by beta-oxidation (*15–19*). The initial uptake of BMIPP is largely determined by regional myocardial blood flow and it is incorporated into the endogenous lipid pool. Since this compound is esterified to triglycerides, it may reflect the size of the endogenous neutral lipid pool, such as triglycerides (*15*). Our previous experiments suggested a close correlation between BMIPP uptake and triglyceride synthesis (*30*) and ATP concentration (*21*). Thus, BMIPP distribution may provide comprehensive information of a certain metabolic function.

Since Yonekura et al. first reported a difference in the distribution of a methyl-branched fatty acid from that of ^{201}Tl in hypertensive rats (*31,32*), various experiments have shown a discrepant distribution of BMIPP from ^{201}Tl in occlusion-reperfusion (*33,34*) and in cardiomyopathy hamster models (*20*). These data indicate that BMIPP distribution may reflect metabolic alterations rather than mere perfusion in various disease conditions. In their preliminary clinical study (*35*), Saito et al. showed greater methylated fatty acid uptake than ^{201}Tl uptake in several patients with unstable angina, possibly due to increases in the triglyceride pool in ischemic tissue. The prolonged reperfusion, however, may possibly decrease the net extraction fraction and increase in the back-diffusion of BMIPP, particularly in patients with myocardial infarction. Knabb et al. (*36*) and Schwaiger et al. (*37*) also observed a delayed recovery of ^{11}C-palmitate uptake in relation to blood flow at 2–4 wk of reperfusion.

TABLE 6
Thallium-201 Uptake Scores in Relation to Wall Motion Scores in 196 Segments

	Wall motion score				
Thallium score	3	2	1	0/−1	Total
3	71 (5)	17 (1)	0 (0)	5 (4)	93 (10)
2	16 (7)	11 (7)	3 (1)	10 (9)	40 (24)
1	4 (2)	6 (2)	8 (1)	19 (10)	37 (15)
0	1 (0)	2 (0)	4 (0)	19 (0)	26 (0)
Total	92 (14)	36 (10)	15 (2)	53 (23)	196 (49)

Figures in parentheses denote the number of segments exhibiting discordant BMIPP uptake.

Relationship to Regional Wall Motion

Generally, there is a close relationship between regional perfusion and function during coronary occlusion in animal and human studies (*38,39*), although transmural and lateral extents often extend beyond this size of perfusion deficits (*40*). On the other hand, reperfused viable myocardium often displays a prolonged mechanical dysfunction, so called "stunned myocardium" (*41*). PET studies indicated sustained metabolic abnormalities under experimental and clinical conditions, including suppressed fatty acid utilization and enhanced glucose utilization (*37,42, 43*). MR spectroscopy studies showed an impaired energy metabolism in postischemic ventricular dysfunction (*44, 45*). The tissue ATP content was also reported to be

TABLE 8
Thallium-201 (Tl) and Wall Motion Scores in Relation to Discordant BMIPP Uptake in 196 Segments

Group	Scores	BMIPP < Tl	BMIPP = Tl	Total
1	Tl = wall motion	13 (12%)	96 (88%)	109 (100%)*†
2	TL < wall motion	11 (33%)	22 (67%)	33 (100%)*
3	Tl > wall motion	25 (46%)	29 (54%)	54 (100%)†
Total		49 (25%)	147 (75%)	196 (100%) (*$p < 0.05$, †$p < 0.01$)

significantly decreased in relation to postischemic dysfunction (*46,47*).

This study in patients with myocardial infarction found a decrease in BMIPP uptake as compared to ^{201}Tl uptake, particularly in patients with acute myocardial infarction and after successful revascularization. Interestingly, such discordant BMIPP uptake was often observed in the areas showing a regional wall motion abnormality but relatively preserved perfusion. Saito et al. (*35*) showed a lower uptake for methylated fatty acid analog rather than ^{201}Tl perfusion in patients with acute myocardial infarction after revascularization therapy who had severe wall motion abnormality. Our clinical results were consistent with their findings. Thus, these areas showing discordant BMIPP uptake are highly likely to include postischemic ventricular dysfunction or "stunned myocardium" (*41*). This discordant BMIPP uptake may reflect decreased pO_2 levels and tissue ATP concentrations that may lead to a switch from fatty acid to glycolytic oxidation despite the restoration of perfusion.

Potential Limitations

This study sampled a spectrum of patients with infarctions, although our data suggest a higher frequency of discordant BMIPP uptake within 4 wk of myocardial infarction. There was a great overlap of regional wall motion scores in each group. There might be inherent limitations in comparing the regional wall motion score in two-dimensional ventriculography with the ^{201}Tl uptake score in three-dimensional SPECT imaging. To minimize errors in assessing the relationship between perfusion and wall motion, the left ventricular myocardium was divided into seven large segments.

The precise uptake mechanisms of BMIPP remains unknown. It is distributed in the myocardium according to regional blood flow and subsequently incorporated into the endogenous lipid pool in the myocardium (*15,30*). Therefore, its uptake may not directly reflect beta-oxidation of fatty acids (*20,48*). Since regional myocardial blood flow may determine the initial distribution of BMIPP, its uptake should be compared with regional perfusion by ^{201}Tl imaging. When a comparison was made, the present study clearly demonstrated differences in the distributions of BMIPP and ^{201}Tl.

Clinical Implications

BMIPP provided excellent images of the left ventricular myocardium. Its distribution was usually similar to that for ^{201}Tl, but it was occasionally lower, particularly in patients with acute myocardial infarction and those who had successful revascularization. In addition, such a discrepancy was often observed in areas showing left ventricular dysfunction with relatively preserved perfusion. Thus, BMIPP may hold promise for identifying metabolic alterations independent of perfusion abnormalities in patients with myocardial infarction. We conclude that metabolic imaging with BMIPP and ^{201}Tl may play an important role in improving our understanding of the relationship between regional perfusion and wall motion abnormalities in patients with myocardial infarction.

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TABLE 9
Thallium-201 (Tl) and Wall Motion Scores in Relation to Discordant BMIPP Uptake in Patients with Acute Myocardial Infarction

Group	Scores	BMIPP < Tl	BMIPP = Tl	Total
1	Tl = wall motion	5 (11%)	42 (89%)	47 (100%)
2	Tl < wall motion	5 (50%)	5 (50%)	10 (100%)
3	Tl > wall motion	19 (56%)	15 (44%)	34 (100%)
Total		29 (32%)	62 (68%)	91 (100%) (*$p < 0.01$)

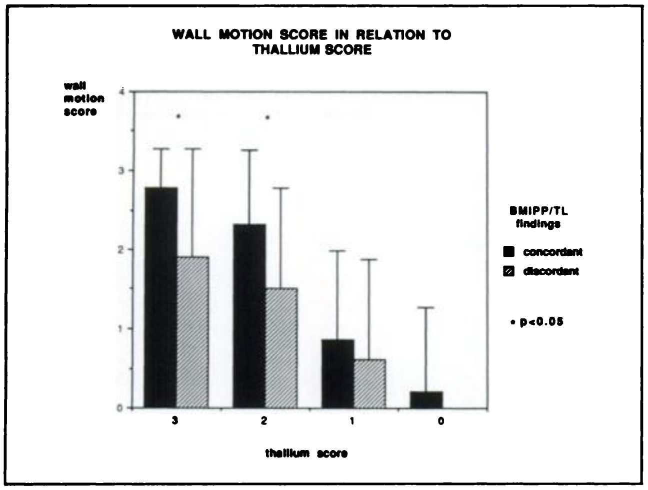

FIGURE 5. Wall motion score in relation to BMIPP/^{201}Tl findings. Each bar represents means and one standard deviation of the wall motion score.

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CORRECTION

In the March 1992 issue of the *Journal*, Table 1 in the article, "Synthesis, Rodent Biodistribution, Dosimetry, Metabolism, and Monkey Images of Carbon-11-Labeled (+)-2α-Tropanyl Benzilate: A Central Muscarinic Imaging Agent," by Mulholland et al. was printed incorrectly. The corrected table is shown below.

TABLE 1
Regional Brain Distribution of [^{11}C]TRB in Rodents

Tissue	Rat (n = 3–5)							Mouse (n = 11)
	kg %dose/g*							
	2 min	20 min	30 min	30 min QNB block	30 min Scopolamine block	60 min	90 min	60 min
Striatum	0.37 ± 0.05	0.62 ± 0.076	0.52 ± 0.02	0.061 ± 0.008	0.064 ± 0.002	0.71 ± 0.097	0.74 ± 0.04	0.326 ± 0.042
Cortex (whole)	0.41 ± 0.075	0.72 ± 0.043	0.52 ± 0.04	0.062 ± 0.008	0.071 ± 0.006	0.61 ± 0.07	0.59 ± 0.061	0.262 ± 0.069
Cerebellum	0.23 ± 0.05	0.17 ± 0.015	0.1 ± 0.009	0.045 ± 0.005	0.051 ± 0.004	0.084 ± 0.012	0.072 ± 0.005	0.025 ± 0.003
Blood	0.048 ± 0.001	0.026 ± 0.005	0.02 ± 0.001	0.019 ± 0.002	0.027 ± 0.002	0.022 ± 0.002	0.024 ± 0.002	0.015 ± 0.001
Striatium/Cerebellum	1.7 ± 0.24	3.69 ± 0.25	5.4 ± 0.52	1.34 ± 0.06	1.26 ± 0.17	8.49 ± 0.42	10.3 ± 0.6	12.7 ± 3.2
%ID/brain	2.93 ± 0.45	4.03 ± 0.31	3.7 ± 0.47	0.57 ± 0.053	0.66 ± 0.006	3.34 ± 0.27	3.11 ± 0.5	4.29 ± 0.06

* Data are given as the mean ± standard deviation.