ORIGINAL

Comparison of washout rate between planar image and polar map image : ^{123}I-BMIPP study

Hideki Otsuka[1,2], Masashi Hieda[1], Hiroyuki Shinbata[1], Akiko Kubo[2] and Hiromu Nishitani[2]

[1]*Department of Radiology, Ehime Prefectural Central Hospital, Ehime, Japan ; and* [2]*Department of Radiology, The University of Tokushima School of Medicine, Tokushima, Japan*

Abstract : Myocardial cells obtain 60-90% of their energy from free fatty acids under aerobic conditions. ^{123}I-BMIPP can demonstrate fatty acid metabolism in the myocardium and is used to evaluate cardiac diseases. Forty-three patients underwent BMIPP imaging in the early (15min) and delayed (4hr) phase, and the washout rate was calculated. We evaluate the washout rate by two methods, the polar map method and the planar image method. The two methods showed close correlation (r=0.473). J. Med. Invest. 50 : 176-179, 2003

Keywords **:** *^{123}I-BMIPP, myocardium, fatty acid, washout rate, nuclear medicine*

INTRODUCTION

The myocardium requires fatty acids, glucose and lactic acid as energy sources to maintain pumping function. About 60-90% of myocardial energy metabolism is supplied by fatty acid under aerobic conditions. Fatty acids metabolism requires a large amount of oxygen, so under the hypoxic or ischemic state, fatty acid metabolism is suppressed and replaced by glucose metabolism, which uses less oxygen than fatty acid metabolism (1).

^{123}I-BMIPP (β-methyl-iodophenyl pentadecanoic acid) can demonstrate fatty acid metabolism in the myocardium and is used to evaluate hypertrophic cardiomyopathy, myocardial infarction, angina pectoris and prognosis (1-4). Dynamic changes and the mechanism of fatty acid metabolism in myocardial cells have not been elucidated. Some recent papers have reported that the washout rate (WR) of ^{123}I-BMIPP provided useful information under some clinical conditions (1, 5, 6). Both polar map images (Bull's eye) and multiplane SPECT images can demonstrate BMIPP uptake.

This study compared the polar map method with the planar image method to evaluate WR.

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Address correspondence and reprint requests to Hideki Otsuka, M.D., Ph.D., Department of Radiology, The University of Tokushima School of Medicine, 3 Kuramoto-cho, Tokushima 770-8503, Japan and Fax : +81-88-633-7174.

PATIENTS AND METHODS

Patients

The study population consisted of 43 patients (34 males and 9 females, aged between 37 and 89 years old, mean 66.6 years old). The diagnosis of myocardial infarction (thirty-four patients), angina (eight patients) or PSVT (Paroxysmal Supraventricular Tachycardia, one patient) was based on all available clinical information and made by the cardiologists in our institute. Informed consent was obtained from all patients before BMIPP examination.

^{123}I-BMIPP study

SPECT (single photon emission computed tomography) was performed 15 min (early) and 4 h (delayed) after intravenous injection of 148MBq ^{123}I-BMIPP with a three-head gamma camera (GCA-9300A/DI, TOSHIBA). The system was equipped with a low energy, high-resolution collimator, and

interfaced with a computer. Data were obtained in a 128×128 matrix with 3 min/rot, 8 deg over 360 °, 4 times continuous mode SPECT. The vertical long, horizontal long and short axis images were reconstructed using backprojection with a Shepp and Logan filter. The threshold level was set at 20% for attenuation, and absorption was corrected by the Chang method.

With the polar map presentation, WR between early and delayed acquisition was calculated by the following equation :
(count at 15 minutes - count at 4 hours) / (count at 15 minutes) ×100 (%).

With planar image presentation, we selected one view at 60 °in all images. The region of interest was set manually by the radiological technician, specially trained for nuclear medicine. The WR was calculated by the same equation.

The results were evaluated by two radiology-board doctors, including a specialist in nuclear medicine.

Statistical analysis

The correlation coefficient was calculated between the WR of polar map presentation and that of planar image presentation. r=0.0-0.2 : no correlation, r=0.2-0.4 : slight correlation, r=0.4-0.7 : close correlation, r=0.7-1.0 : very close correlation.

RESULTS

The results are shown in Figures 1, 2. Fig. 1 demonstrates polar map images of acute myocardial infarction (#2, 100% occlusion). The accumulation in the inferior wall (territory of the right coronary artery, RCA) was impaired in both the early and delayed phase. The washout of BMIPP was delayed. The two methods showed close correlation (r=0.473) in Fig. 2. When linear fitting was applied, the result was Y=0.975X - 14.2. The outlier represented the WR of a 74-year-old female with acute myocardial infarction (#6). The value was -81.4 in the polar map image and 22.1 in the planar image.

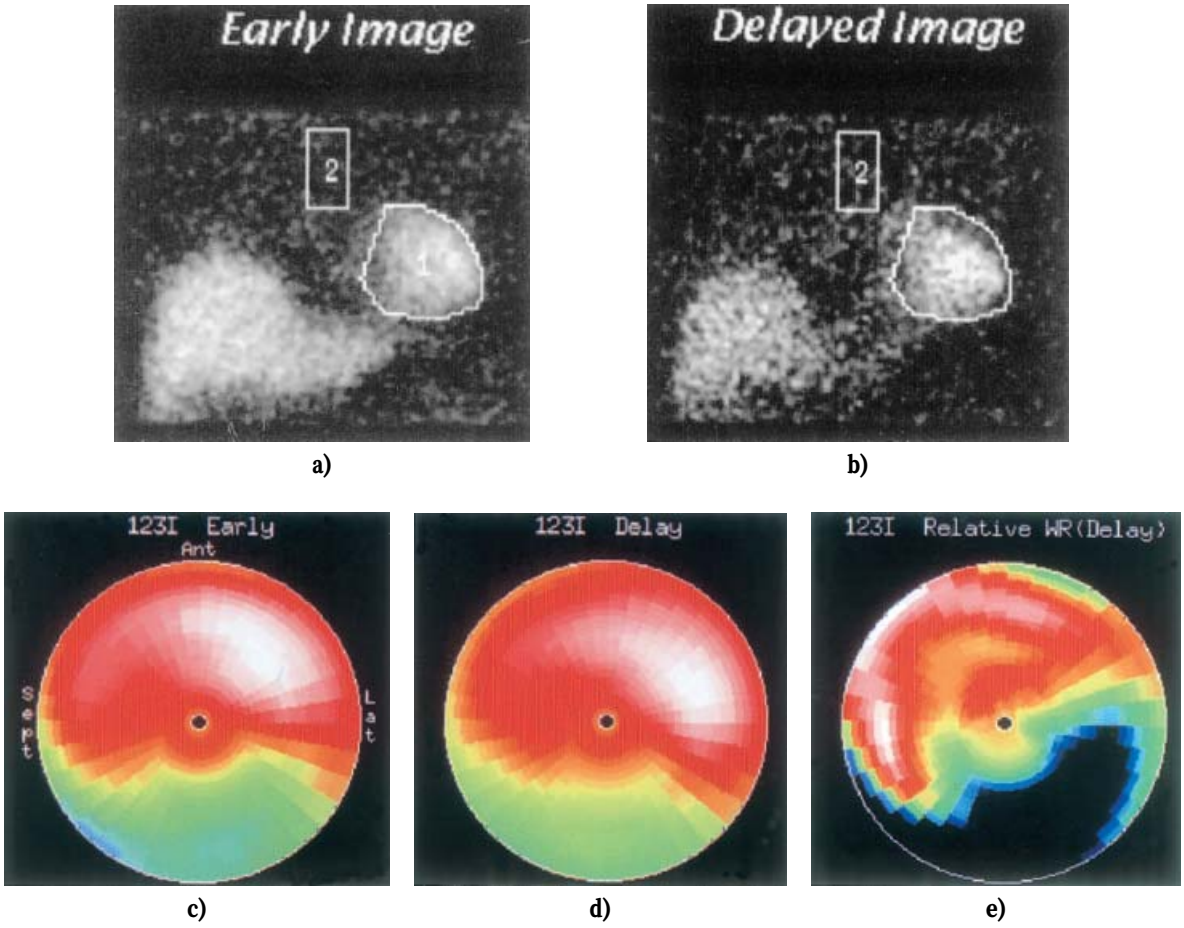

Fig. 1. Acute myocardial infarction (#2, 100%) a) early planar image, ROI 1 count : 10853, b) delayed planar image, ROI 1 count : 6857, WR=36.8
c) early polar map presentation, d) delayed polar map presentation, e) washout rate, WR=12.0

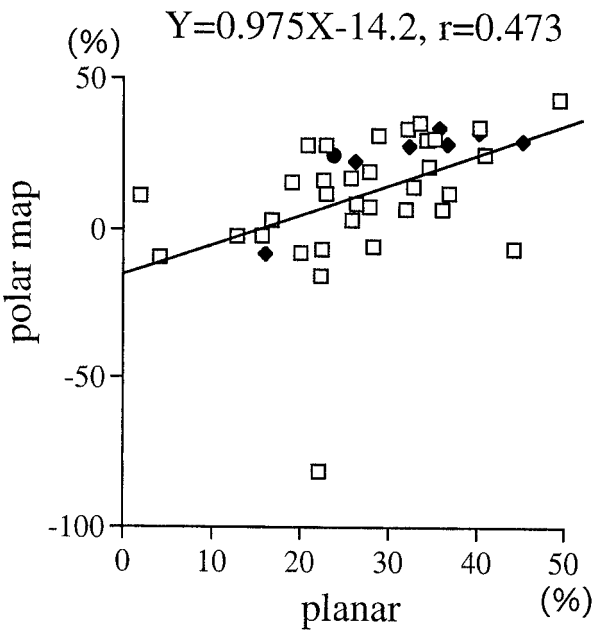

Fig. 2. Washout rate. □ : myocardial infarction, ◆ : Angina, ● : PSVT
Y=0.975X - 14.2, r=0.473

DISCUSSION

Fatty acids are introduced into myocardial cells via CD36-positive fatty acid binding protein on the myocardial cell membrane and are acylated with ATP and β-oxidized in mitochondria. About 70% of the incorporated fatty acids are accumulated in the lipid pool and the others are metabolized to PIPA (p-iodophenyl acetic acid) in mitochondria and diffuse back from the lipid pool into the blood. ^{123}I-BMIPP is considered an indicator of fatty acid metabolism and is used for the evaluation of some kind of heart disease (7-10). The washout of BMIPP increased during exercise in normal myocardium but not in ischemic myocardium. The decreased BMIPP washout rate after angioplasty indicates improved fatty acid utilization in chronic coronary artery disease. Myocardial fatty acid uptake increased and its washout decreased in diabetes mellitus. In HCM (hypertrophic cardiomyopathy), the severity of the BMIPP defect could indicate cardiac function and predict the outcome. The peripheral region of a myocardial infarction sometimes presents impaired BMIPP uptake, demonstrating perfusion-BMIPP SPECT 'mismatch'. Such a mismatch region may become infarcted in the future. A larger mismatch area indicates a higher risk of another cardiac event after the first event (2). After reperfusion of severe transient ischemia, the recovery of fatty acid metabolism is sometimes delayed. The stunned myocardium shows impaired BMIPP uptake and BMIPP study is used as a memory image of previous ischemic lesions due to coronary stenosis or spasm.

Either multiplane tomographic images or polar map display can be used to evaluate fatty acid metabolism. The objectivity of polar maps is superior. Some reports have described about the advantages of polar display (11, 12). This method assisted observers to more consistently identify and quantify myocardial perfusion defects or impaired fatty acid metabolism. However, polar maps sometime overestimate the extent of lesions at the cardiac base, because the cardiac base is larger than the cardiac apex on polar maps due to the concentric circle arrangement. Accurate evaluation may not be possible if polar maps are constructed with inappropriate settings for the area of cardiac muscles, such as settings that miss part of the cardiac muscles while including non cardiac areas (13). Garcia *et al* described that selecting which method to use depends largely on the application and on the instrumentation and technical expertise available (11). In this study, the WR obtained by planar images in one direction closely correlated with that by polar mapping, indicating the importance of confirmation of SPECT source images.

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