Improved Myocardial Fatty Acid Utilization after Percutaneous Transluminal Coronary Angioplasty

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Exercise-reinjection ^{201}Tl imaging and resting 20-min and 3-hr BMIPP imaging were performed before and 4 mo after percutaneous transluminal coronary angioplasty (PTCA) in a patient with effort angina. Before PTCA, exercise ^{201}Tl imaging showed decreased ^{201}Tl activity in the septal wall, with significant fill-in on the reinjection ^{201}Tl image. The resting 20-min BMIPP image showed decreased activity in the septal wall, with a slight redistribution on the 3-hr BMIPP image. The ^{201}Tl and BMIPP images 4 mo after PTCA showed significant improvement in the ^{201}Tl pattern and BMIPP uptake in the septal wall with no abnormally decreased activities.

Key Words: iodine-123 BMIPP; ischemic heart disease; percutaneous transluminal coronary angioplasty; myocardial fatty acid

J Nucl Med 1995; 36:1605–1607

Metabolic conditions in ischemic but viable myocardium can recover after revascularization therapy. Tamaki et al. demonstrated a decrease in [^{18}F]-deoxyglucose (FDG) uptake after coronary artery bypass grafting in ischemic but viable myocardium (*1*). Although fatty acid is the main cardiac energy source during resting conditions, little is known about fatty acid utilization before and after revascularization. Recently, ^{123}I-labeled 15-(p-iodophenyl)3R, S-methylpentadecanoic acid (BMIPP) has been proposed as a potential fatty acid probe for myocardial fatty acid utilization (*2–4*). In patients with ischemic heart disease, decreased myocardial BMIPP uptake compared with ^{201}Tl in the ischemic zone area was reported (*5*). We hypothesized that fatty acid utilization would recover after successful percutaneous transluminal coronary angioplasty (PTCA). We present a case of ischemic heart disease, which demonstrates significant improvement in BMIPP uptake in the ischemic zone after PTCA.

Received April 25, 1994; revision accepted Aug. 1, 1994.

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CASE REPORT

A 68-yr-old man suffering from effort angina was admitted to our hospital, and exercise reinjection ^{201}Tl imaging and resting BMIPP imaging were performed before and 4 mo after PTCA. The patient did not have a history of previous myocardial infarction and had no ongoing angina at the time of follow-up.

Coronary Angiography

The patient underwent coronary angiography, which revealed 90% stenosis in the luminal diameter of the left anterior descending artery. Percutaneous coronary angioplasty was performed successfully, showing less than 25% of stenosis in the luminal diameter (Fig. 1).

BMIPP and Thallium Studies

BMIPP imaging was performed with an injection of 111–148 MBq BMIPP during rest followed by a 20-ml saline flush through an intravenous cannula inserted before the start of the study. SPECT images were acquired 20 min and 3 hr after injection (resting 20-min BMIPP and 3-hr BMIPP) using a three-headed SPECT camera with high-resolution, parallel-hole collimators. A total of 60 projection images were obtained over 360° in 6° increments, with 30 sec per view. The data were recorded in 128 × 128 matrices into the magnetic disc. The energy discrimination was centered on 159 keV with a 20% window. To reconstruct transaxial tomographic images from the acquisition data, Butterworth and ramp filters were used. The parameter of the Butterworth filter was order 8, and the cutoff frequency was 0.15 cycles/pixel.

Within a week of the BMIPP study, exercise stress ^{201}Tl SPECT imaging was performed using a supine bicycle ergometer. Exercise was started with a workload of 25 W and increased by 25 W intervals for every 2 min of stress. Exercise was terminated when either severe chest pain, serious arrhythmia, ST depression of more than 0.2 mV and/or fatigue occurred. One minute before cessation of exercise, 74 MBq ^{201}Tl were injected and an exercise image was obtained under the same acquisition conditions and reconstruction method used for the BMIPP SPECT study, with the exception that energy discrimination was centered on 70 keV with a 20% window. An additional 37 MBq ^{201}Tl were injected at rest 3–4 hr after the first injection during exercise, and ^{201}Tl reinjection imaging was started within 10 min of the second injection.

SPECT

Before PTCA, exercise ^{201}Tl imaging showed decreased ^{201}Tl activity in the septal wall, with significant fillin on the ^{201}Tl reinjection image. On the other hand, the resting 20-min BMIPP image

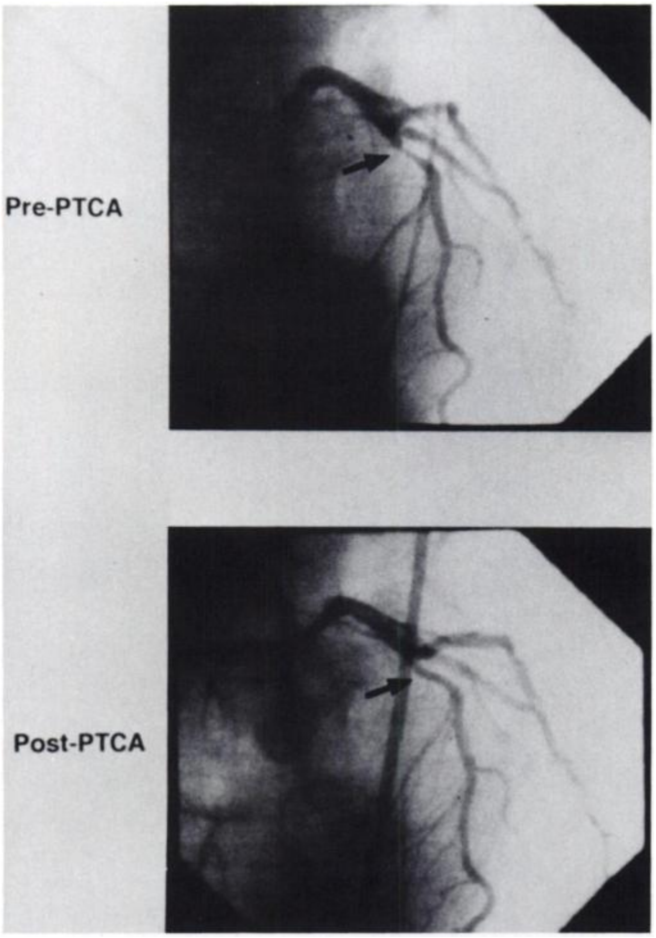

FIGURE 1. Coronary angiography before and after percutaneous transluminal coronary angioplasty (PTCA). The pre-PTCA angiogram (upper) revealed significant stenosis in the left ascending descending artery, which improved to less than 25% of stenosis in the luminal diameter after PTCA (lower).

showed apparent decreased activity in the septal wall, with a slight redistribution on the 3-hr BMIPP image (Fig. 2).

As illustrated in Figure 3, ^{201}Tl and BMIPP imaging 4 mo after PTCA showed significant improvement in ^{201}Tl pattern and BMIPP uptake in the septal wall, with no apparent abnormally decreased activities with both ^{201}Tl and BMIPP. When ROIs of 5×5 pixels were placed on the center of the septal and lateral walls for normal reference regions on the transaxial slices on the 20-min BMIPP images, the septal-to-lateral ratio before PTCA was 0.53, which increased to 0.90 after coronary artery intervention.

DISCUSSION

We found decreased myocardial BMIPP uptake in the area of stress-induced ischemia on ^{201}Tl imaging, which is consistent with our previous report that impaired fatty acid utilization in ischemic myocardium already exist during rest (*5*). In addition to these observations, decreased BMIPP uptake recovered significantly 4 mo after revascularization therapy, indicating that impaired fatty acid utilization is reversible. This is concordant with glucose metabolism normalization after coronary artery bypass grafting using PET and FDG (*1*). Terada et al. reported a case of acute coronary syndrome with a slight improvement in BMIPP uptake 16 days after PTCA (*6*). Apparent decreased BMIPP uptake was still observed in the postischemic myocardium, however, even though PTCA was successfully performed. The incomplete recovery of decreased BMIPP uptake in their observation might be due to the short interval of 16 days between PTCA and BMIPP imaging. In contrast, the interval for our patient was 4 mo, which should be sufficient for myocardial metabolic alteration after vascular intervention. Tamaki et al. noted that the discordance between BMIPP and ^{201}Tl uptake frequently occurs before 4 wk after the onset of myocardial infarction. In contrast, the frequency of discordance between the two tracers was not high after 4 wk (7), suggesting that the recovery of fatty acid metabolism might be a time-dependent phenomenon. In addition, the experimen-

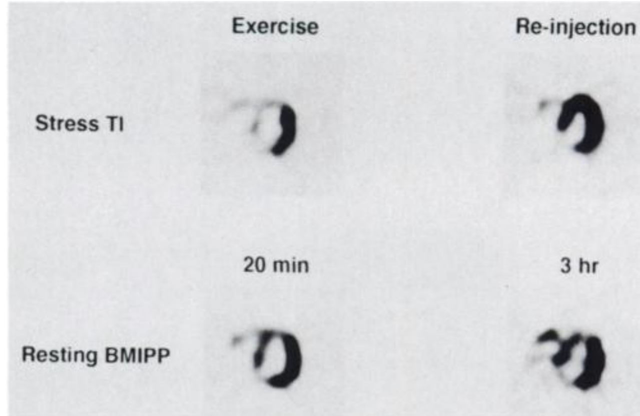

FIGURE 2. Transaxial slices of exercise (upper left), ^{201}Tl reinjection (upper right), 20-min (lower left) and 3-hr BMIPP (lower right) imaging 3 wk before PCTA. Decreased activity in the septal wall was observed on the exercise ^{201}Tl image with significant fillin on the ^{201}Tl reinjection image, indicating exercise-induced ischemia. Significantly decreased BMIPP activity was noted on both the 20-min and 3-hr BMIPP images.

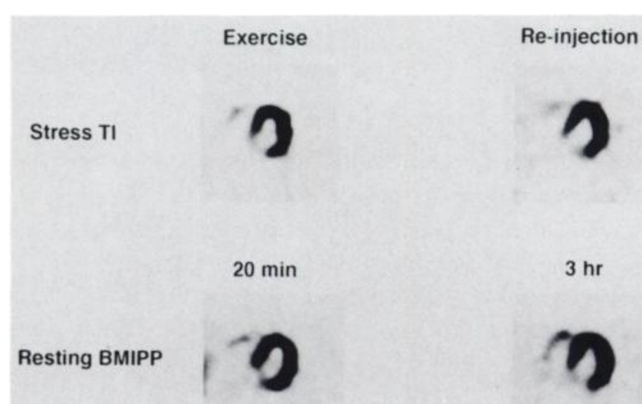

FIGURE 3. Transaxial slices of exercise (upper left), reinjection ^{201}Tl (upper right), 20-min (lower left) and 3-hr BMIPP (lower right) imaging 4 mo after PCTA. A significant improvement of radioactivities was noted on both ^{201}Tl and BMIPP imaging.

tal study using PET and FDG showed sustained metabolic derangement after transient ischemia (*8*). Thus, sufficient time after PTCA may be one of the important factors to influence the recovery in BMIPP uptake in the salvaged area by PTCA. Persistent increased FDG uptake several months after successfully performed revascularization was still observed, however, by Marwick et al. (*9*), indicating that myocardial glucose metabolism remains abnormal in a considerable portion of salvaged myocardium. Further investigation with a number of subjects is needed to clarify the role of myocardial fatty acid metabolism after revascularization.

CONCLUSION

Our patient had significant improvement in myocardial fatty acid utilization after PTCA, suggesting that serial analysis of BMIPP imaging might provide insights into the understanding of tissue metabolic alternations after revascularization.

REFERENCES

1. Tamaki N, Yonekura Y, Yamashita K, et al. Positron emission tomography using fluorine-18 deoxyglucose in evaluation of coronary artery bypass grafting. *Am J Cardiol* 1989;64:860–865.
2. Knapp FF Jr, Ambrose KR, Goodman MM. New radioiodinated methyl-branched fatty acids for cardiac studies. *Eur J Nucl Med* 1986;12:S39–S44.
3. Dudczak R, Schmoliner R, Angelberger P, Knapp FF, Goodman MM. Structurally modified fatty acids: clinical potential as tracers of metabolism. *Eur J Nucl Med* 1986;12:S45–S48.
4. Yonekura Y, Brill AB, Som P, et al. Regional myocardial substrate uptake in hypertensive rats: a quantitative autoradiographic measurement. *Science* 1985;227:1494–1496.
5. Matsunari I, Saga T, Taki J, et al. Kinetics of iodine-123-BMIPP in patients with prior myocardial infarction: assessment with dynamic, rest and stress images compared with stress ^{201}Tl SPECT. *J Nucl Med* 1994;35:1279–1285.
6. Terada K, Sugihara H, Taniguchi Y, et al. A case of acute coronary syndrome followed by ^{201}Tl, ^{123}I-BMIPP and ^{123}I-MIBG myocardial imagings before and after PTCA. *Jpn J Nucl Med* 1993; 30:1459–1463.
7. Tamaki N, Kawamoto M, Yonekura Y, et al. 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. *J Nucl Med* 1992; 33:659–667.
8. Schwaiger M, Schelbert HR, Ellison D, et al. Sustained regional abnormalities in cardiac metabolism after transient ischemia in chronic dog model. *J Am Coll Cardiol* 1985;6:336–347.
9. Marwick TH, MacIntyre WJ, Lafont A, Nemec JJ, Salcedo EE. Metabolic responses of hibernating and infarcted myocardium to revascularization: a follow-up study of regional perfusion, function and metabolism. *Circulation* 1992;85:1347–1353.

Scatter

(Continued from page 3A)

our mind. Innocent, without bias, fresh. Rather a charming substitute for ignorance: the lack of knowledge, the guilt of having ignored or neglected an area.

Did this stammer over the choice of word reflect the arrogance of the successful, a disorder affecting the powerful in institutional medicine, a dyslexia of sorts that does not permit the confession of "ignorance?" Or did it truly reflect innocence, a willingness to learn, to begin anew, to sail uncharted waters, to recognize the achievement of others and to grow?

And what of those areas about which I am uninformed? I hope that I will only be *innocent*.

Stanley J. Goldsmith, MD
Editor-in-Chief, The Journal of Nuclear Medicine
September 1995