Myocardial Imaging Using 11C-CoQ10 with Positron Emission Tomography

III. 1 Myocardial Imaging Using ^{11}C-CoQ_{10} with Positron Emission Tomography

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Introduction

Coenzyme Q_{10}(CoQ_{10}) is not only an endogenous essential substance found in the mitochondrial electron transfer chain, but also a drug useful for treatment of heart diseases. The therapeutic effect of exogenous CoQ_{10} reflects the fact that defficiency of CoQ_{10} underlies some cardiac disturbances. And it has been reported that impaired cardiac tissue avidly accumulates exogenous CoQ_{10}.

In view of these findings, we have assumed that myocardial uptake of exogenous CoQ_{10} can be utilized as a new index of regional myocardial bioenergetics, especially for evaluating the state of impaired myocardium. To investigate our assumption, we have labeled CoQ_{10} with ^{11}C, and examined whether ^{11}C-CoQ_{10} is useful as a myocardial imaging tracer for PET.

Methods

^{11}C-CoQ_{10} with a specific activity of 4-5 Ci/mmol was synthesized by the reaction of 3-methyl CoQ_{10} with $^{11}CH_3I$ [1], and emulsified with phospholipid solution (liposomal preparation) [2]. ^{45}Ti-DTPA[3] and ^{18}FDM[4] were synthesized by the method described previously.

Myocardial imaging study was performed in a normal dog with ^{11}C-CoQ_{10}, followed by sequential use of ^{45}Ti-DTPA for evaluating blood volume and ^{18}FDM for evaluating glucose metabolism. Three regions of interests(ROI) were assigned on images and the concentration of radioactivity were calculated as a differential absorption ratio(DAR); DAR =(count/pixel) $\times$(body weight /total count).

Results

Fig.1-a shows a cross-sectional image of normal canine heart using ^{11}C-CoQ_{10}. The heart can be visualized as a large mass. The small mass on the right side corresponds to the narrow of the vertebra. The ^{11}C-CoQ_{10} did notsatisfactorily differentiate the myocardium because of the relatively high

radioactivity in the blood pool. Fig.1-b shows the image of the same canine heart using ^{18}FDM. The myocardium is clearly delineated as a horseshoe-shaped pattern.

Fig.2 shows a myocardial kinetic curve of ^{11}C-CoQ_{10} by PET. Contamination of radioactivity from the blood pool into the myocardium was estimated by ^{45}Ti-DTPA data, and shown as the filled columns. It was revealed that ^{11}C-CoQ_{10} accumulated in the myocardium with time.

Discussion

In spite of a high accumulation of ^{11}C-CoQ_{10} (liposomal preparation) in the rat heart, the cross-sectional image of the normal canine heart with ^{11}C-CoQ_{10} does not satisfactorily delineate the myocardium because of the relatively high radioactivity in the blood pool. Possible causes are as follows; 1)species difference between dog and rat, 2)variation in the properties of liposomes(e.g. size, affinity). 3)problems concerning PET measurement(e.g. injected dose, partial volume effect). However, the kinetic data for myocardial tissue, corrected for blood spillover of radioactivity, showed an increased uptake of ^{11}C-CoQ_{10} with time. This result demonstrated clearly that exogenous ^{11}C-CoQ_{10} is incorporated into the normal myocardium over a short period(45 min).

In conventional myocardial imaging, ^{18}FDG is a common tracer for evaluating glucose metabolism according to the compartment model[5]. However, information about metabolic process subsequent to hexokinase are unavailable from this model, because ^{18}FDG is trapped metabolically in the tissue on its very first step(hexokinase), and no further catabolism is supposed to occur. On the other hand, CoQ_{10} has an important role as a redox carrier in the election transfer chain, so has the potential to be a new tracer for evaluating this process. Now we think that the application of ^{11}C-CoQ_{10} imaging to myocardia exhibiting abnormal metabolism(e.g. ischemia, cardiomyopathy) should be interesting.

References

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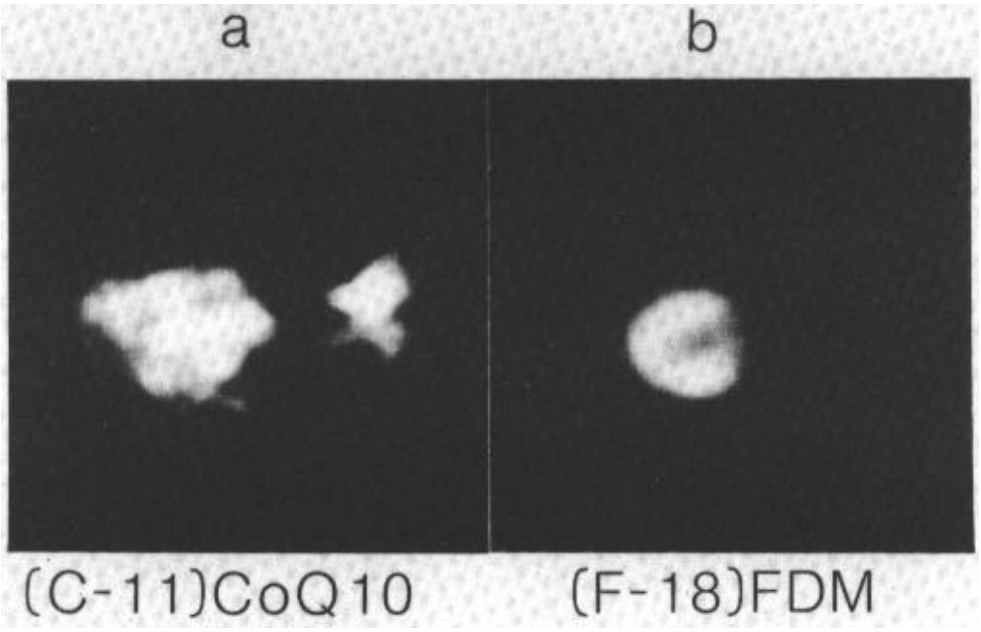

Fig. 1. Cross sectional images of the canine heart with ^{11}C-CoQ_{10} and ^{18}F-FDM.

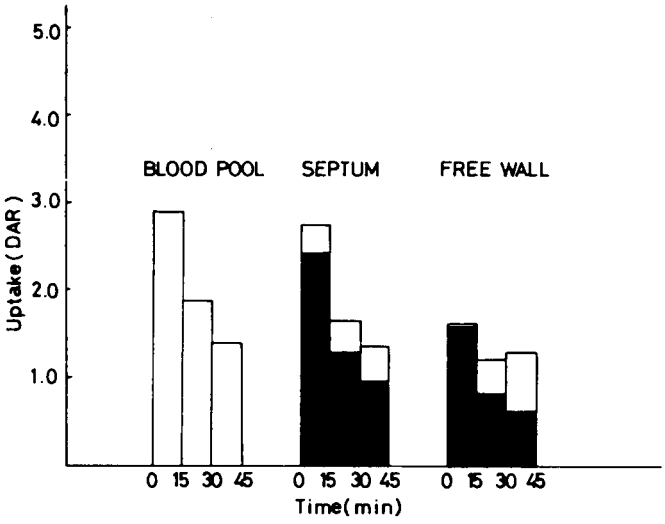

Fig. 2. Myocardial tissue kinetic curve of ^{11}C-CoQ_{10}. Dark zone shows the contamination from the blood pool so calleld blood spillover of activity into myocardium. White zone in the septum and free wall indicates the real myocardial uptake of ^{11}C-CoQ_{10}.