Quantitative Analysis of ^{11}C-acetate in Nasopharyngeal Carcinoma with Positron Emission Tomography

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Abstract

Although several kinetic models have been proposed for myocardium ^{11}C-acetate PET quantitative studies, currently there are no reports applying them to tumor diagnosis. In this study, we adopted one of the existing models for performing quantitative analysis on nasopharynx carcinoma (NPC) patients. Ten patients were included, with five NPC and five control subjects. For each subject, one ROI of nasopharynx area and one ROI of muscle area were drawn on PET images. Four rate constants were then estimated using the non-linear least squares method. The extraction fraction K was calculated from these estimated parameters. We found K showed significant difference in the two groups, while the average K of nasopharynx areas was 0.2675 ± 0.1562 in NPC and 0.0763 ± 0.0425 in control patients. In addition, a higher ^{11}C-acetate inflow rate constant from plasma was observed in the NPC nasopharynx area, while the clearance rate was lower. Meanwhile, the rate constants of muscle area in the two groups showed no significant difference. These results indicate that, for tumors, those estimated parameters will be significantly different due to the characteristics of ^{11}C-acetate uptake. In conclusion, our results proved the portability of applying kinetic model analysis in ^{11}C-acetate tumor studies. Such an analysis can provide physicians with objective reference for clinical diagnosis.

Keywords: ^{11}C-acetate, PET, Quantitative analysis, Kinetic model

Introduction

Positron emission tomography (PET) has been widely used in clinical diagnosis because of its ability to produce medical functional images. Among the various kinds of tracers in PET, ^{11}C-acetate is one of the most commonly used. Since acetate will be rapidly taken up in tissue and then metabolized to CO_2 via the tricarboxylic acid (TCA) cycle post injection, it is often adopted for cardiac functional evaluation [1-2]. Recent reports suggest that ^{11}C-acetate has also been validated as a useful tracer for tumor detection [3-6]. Abnormally high metabolism of ^{11}C-acetate is observed in regions with possible tumors due to the extreme need of energy through the TCA cycle in tumors.

Although ^{11}C-acetate can be helpful for tumor diagnosis, some diagnostic references are needed in clinical practice because of the poor spatial resolution and limited signal-to-noise ratio of PET images. One diagnostic tool is the quantitative analysis of ^{11}C-acetate PET images. Quantitative analysis manipulates the kinetic models to monitor *in vivo* metabolic activities and obtains physiological parameters through numerical estimation. Several kinetic models of cardiac ^{11}C-acetate PET have been proposed [7-10]. However, there was no discussion about applying those models in other organs or systems, nor has the ^{11}C-acetate PET quantitative analysis of tumors been developed. Therefore, we attempted in this study to apply one existing kinetic ^{11}C-acetate model to tumors. PET images and data of nasopharyngeal carcinoma (NPC) patients were examined. Physiological parameters were obtained from their data, and further used to compare with those obtained from normal subjects. The aim of this study was to assess whether the chosen model would provide meaningful information from good estimates of physiological parameters for clinical diagnosis.

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Materials and Methods

Subjects

Ten subjects were included in this study, five among them with NPC and the other five normal cases acting as controls. All NPC patients were in stage IV according to the JACC 1992 staging system. Disease status was determined by physical examination, bone scan, CT and/or MRI study, clinical follow-up and history. Informed consent was obtained from all patients.