IV. 1 Differential Diagnosis of Solitary Pulmonary Nodules with Positron Emission Tomography Using $^{11}$C-L-Methionine

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Introduction

Malignant tumors are generally characterized by uncontrolled cell proliferation which requires increased metabolic activity proven by various experiments. The increase of metabolic activity of malignant tumor has been a target for positron emission tomography (PET) study. These studies using $^{18}$F-2-deoxy-D-glucose ($^{18}$FDG) or $^{11}$C-L-methionine ($^{11}$C-Met) have shown non-invasive metabolic grading of glioma$^{1}$ and lung cancer$^{2}$ which were strongly correlated with their histopathologic grade of the malignancy.

For the prediction of the nature of the solitary pulmonary nodule, the value of computed tomography (CT) has been studied widely. CT visualizes only the shape of abnormality, quantifies only the X-ray attenuation density of the tissue, and gives no information about the metabolic and biological nature of the tumor. Then, number of CT studies conclude that CT of lung nodules cannot be histospecific, because of the disappointing results of the indefinite nature of non-calcifying small nodules, although the presence of calcification is a strong indicator of benignancy.$^{3-5}$

In this report, we describe two cases studied by high resolution PET and $^{11}$C-Met to predict the nature of the small solitary pulmonary nodule.

Care Report

Case 1. 69-year-old male with diabetes, hypertension, and angina was referred to us because of 1.5×2.0 cm solitary pulmonary nodule discovered in a chest X-ray. CT showed an oval nodule without calcification and relatively smooth edge, adjacent to posterio lpleura in the right upper segment of the lower lobe (Fig. 1a). Brushing cytology test under broncho-fiberscope showed class III (suspicious cells, atypical cells consistent with border line lesion), but recurrent chest pain attacks of angina withhold him from repeating examination. PET was performed after injection of 18 mCi of $^{11}$C-Met, and each 5 min, images were obtained from 0 to 50 min over 7 slice levels with 7.0 mm width at the same time (PT 931/04, CTI, U.S.A.). Very high accumulation of $^{11}$C-Met in the tumor was observed and tumor/muscle ratio was
6.0 (Fig. 1b). This finding was interpreted as high possibility of malignancy which was recommended needle biopsy. The biopsy demonstrated squamous cell carcinoma, and radiotherapy was selected because of ischemic heart disease.

Case 2. 63-year-old female with no complaints was referred to us about the solitary pulmonary nodule which was discovered in a chest X-ray of rural resident health assessment program. CT showed a 1.5×1.5 cm nodular lesion close to the left cardio-phrenic angle (Fig. 2a). The nodule had soft tissue density, no calcification and smooth edge. Sputum cytology test was class I. Brushing cytology and bacteriology test under broncho-fiberscope performed twice showed no specific finding. But previous films proved the nodule as a new lesion. PET study with 11 mCi of $^{11}$C-Met showed no specific isotope accumulation in the tumor, radioactivity in the tumor was almost the same as the normal mediastinal structure and tumor/muscle ratio was 1.2 (Fig. 2b). This was interpreted as benign tumor, and lung biopsy under thoracotomy proved granuloma.

Discussion

We have shown that $^{11}$C-Met is one of the most useful amino acids for the detection of cancer through an experimental study and clinical studies of lung cancer. The accumulation of $^{11}$C-Met in the tumor was closely correlated to the tumor viability such as benign or malignant, viable or necrotic. Also the relationship between histologic type of primary lung cancer and $^{11}$C-Met uptake has been demonstrated. Although these clearly showed the role of PET as pathophysiological imaging of tumor, patients suspected of early cancer have never been studied. In this study, we investigated the potential role of PET in the early diagnosis of lung cancer, and two cases suspected of early lung cancer were correctly diagnosed. High resolution PET using $^{11}$C-Met seems to be very useful to predict the nature of the small lung nodule. This study may open a possibility of the transition of PET from research to clinical modality.

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References

Fig. 1a. Chest CT scan of Case 1 showing lung tumor and giving anatomical reference for PET image.

Fig. 1b. Lung tumor image of Case 1 with PET (PT931/04, CTI) at 30 min. after injection of 18 mCi of $^{11}$C-Met. Tumor and bone marrow in the sternum show the uptake of $^{11}$C-Met.
Fig. 2a. Chest CT scan of Case 2 showing a nodule of 1.5×1.5 cm in the left cardio-phrenic angle.

Fig. 2b. Lung tumor image of Case 2 with PET at 30 min after injection of 11 mCi of $^{11}$C-Met. Arrow is liver. Arrow head is