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Technetium-99m tetrofosmin uptake in lung cancer: Comparison with thallium-201

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Technetium-99m tetrofosmin and thallium-201 lung SPECT imaging were performed in a patient with adenocarcinoma of the lung. Significant activities in the lung lesion were clearly depicted on both technetium-99m tetrofosmin and thallium-201 SPECT imaging. The early uptake, delayed uptake ratios and retention indices of the tumor were 2.75, 2.39 and −13.1 for thallium-201 imaging and 3.09, 2.27 and −26.5 for technetium-99m tetrofosmin imaging, respectively. This preliminary report suggests that technetium-99m tetrofosmin may have potential as a tumor imaging agent.

Key words: technetium-99m tetrofosmin, thallium-201, lung cancer

INTRODUCTION

THALLIUM-201 is useful for detecting suspected or known lung cancer, via single photon emission computed tomography (SPECT).[1] Recently, efforts have been made to seek a tumor imaging agent that can be labeled with technetium-99m. Technetium-99m sestamibi (Tc-99m sestamibi), which is widely used as a technetium-99m labeled myocardial perfusion imaging agent, has been reported to have the potential to accumulate in various tumors including lung cancer.[2–4] More recently, technetium-99m tetrofosmin (Tc-99m tetrofosmin) has been suggested as a new myocardial perfusion imaging tracer,[5–7] but the diagnostic potential of this new tracer for tumor imaging is still unclear.

We report a patient with lung cancer who underwent both thallium-201 and Tc-99m tetrofosmin imaging.

CASE REPORT

A 73 y.o. male patient, with a history of surgical resection of left lung cancer 1.5 years ago (adenocarcinoma), entered our hospital for surgical removal of a newly developed right lung lesion. Before surgery, thallium-201 and Tc-99m tetrofosmin SPECT imaging were performed, within a one week period. At 10 min and 3 hours after the injection of thallium-201 (150 MBq), early- and delayed-thallium-201 lung SPECT images were obtained. Similarly, Tc-99m tetrofosmin SPECT images were acquired at 10 min and 3 hours after the injection of Tc-99m tetrofosmin (740 MBq). Imaging was performed with a three-headed SPECT system (GCA9300A/HG, Toshiba) with low-energy high-resolution parallel hole collimators. A total of 60 projection images were obtained over 360 degrees in 6 degree increments, at 30 sec per view for both thallium and Tc-99m tetrofosmin SPECT. The energy discriminator was centered on 70 keV for thallium and 140 keV for Tc-99m tetrofosmin with a 20% window. The data were recorded in 128 × 128 matrices on a magnetic disc. Butterworth and Ramp filters were used to reconstruct transaxial tomographic images from acquired data. The parameter of the Butterworth filter was order 8, and the cut-off frequency was 0.15 cycles/pixel.

As shown in Figure 1, both thallium-201 and Tc-99m tetrofosmin imaging clearly demonstrated high tracer activities in the lung lesion corresponding to the lung nodule on X-ray CT.

Operative findings revealed a 1.7 × 1.2 cm adenocarcinoma in the lateral segment of the middle lobe in the right lung.

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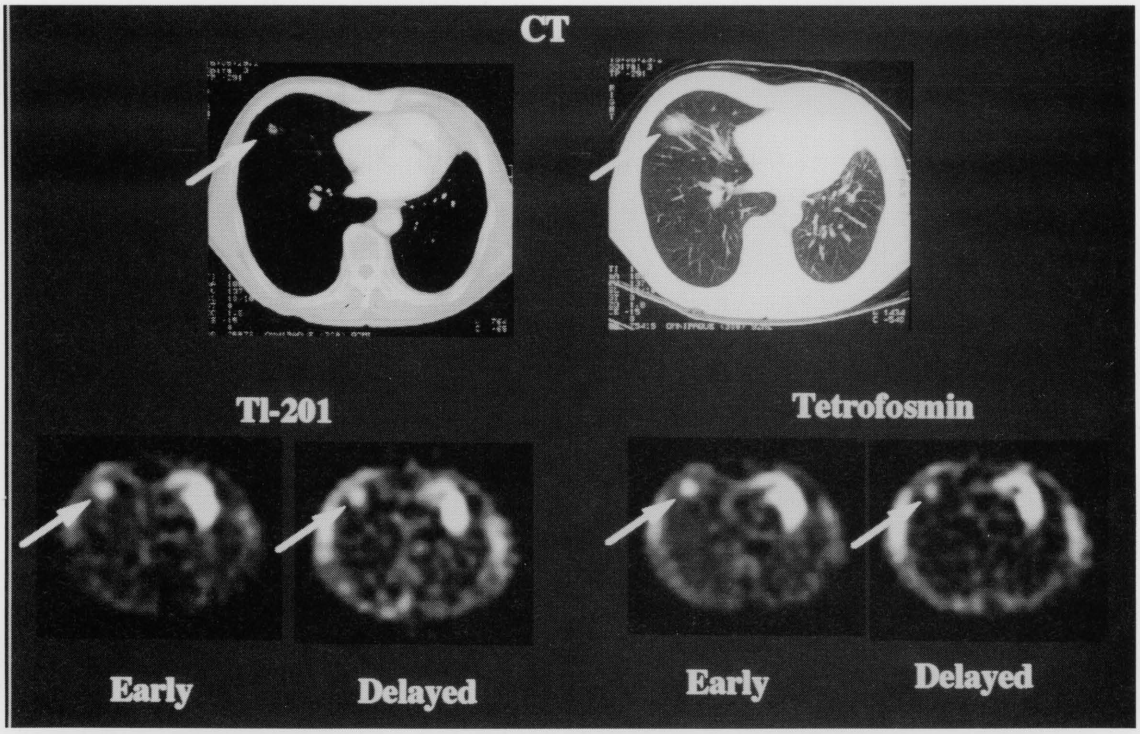

Fig. 1 Upper: X-ray CT shows an abnormal shadow in the right lung (arrow). Lower left: Early and delayed thallium-201 SPECT images demonstrate abnormal accumulation corresponding to the lesion (arrow). Lower right: Early and delayed Tc-99m tetrofosmin images also demonstrate accumulation in the same area (arrow). Abnormal accumulation in the lesion is more prominent on the early image.

Quantitative analysis

Uptake ratios and retention indices of the lung lesion were calculated for both thallium-201 and Tc-99m tetrofosmin images, as originally described by Tonami et al.[1] Briefly, a region of interest (ROI) was placed over the tumor, and the contralateral normal lung was used as background. The background ROI was placed carefully to avoid contamination from the heart. The mean ROI counts were measured, and the uptake ratios of the lesion to the contralateral normal lung were calculated for both early and delayed images. The retention index was obtained by means of the following equation:

$$\frac{\text{Delayed ratio} - \text{Early ratio}}{\text{Early ratio}} \times 100$$

The early, delayed uptake ratios and retention indices of the tumor were 2.75, 2.39 and −13.1 for thallium-201 imaging and 3.09, 2.27 and −26.5 for Tc-99m tetrofosmin imaging, respectively.

DISCUSSION

Thallium-201 via SPECT imaging has been proven to be valuable for the evaluation of suspected lung cancer,[1] but thallium-201 has several suboptimal physical characteristics. The emitted energy is lower than ideal and the radiation dose applied to the patient is relatively high. Technetium-99m has been suggested as a better marker for gamma camera imaging. In contrast to thallium-201, technetium-99m has higher photon energy and a shorter half life, resulting in more flexible patient scheduling, a smaller radiation dose, larger injected dose and better image quality. Recent efforts have therefore focused on a tumor imaging agent that can be labeled with technetium-99m. Tc-99m (V) DMSA and Tc-99m sestamibi are promising tumor imaging agents. Hirano et al. reported the use of Tc-99m (V) DMSA for the evaluation of primary lung cancer with good results.[8] Furthermore, several studies have demonstrated the ability of Tc-99m sestamibi to detect various tumors such as breast, parathyroid, brain and lung tumors.[2–4] Tc-99m tetrofosmin has recently been suggested as a new myocardial perfusion imaging agent.[5–7] Tc-99m tetrofosmin has several advantages. It is provided in kit form and can be labeled rapidly at room temperature without heating time. In addition, compared with Tc-99m sestamibi, Tc-99m tetrofosmin has been reported to show faster clearance from both the lung and liver, resulting in higher quality images at comparable imaging times.[5]

In this report, we intentionally selected a patient with a highly suspected malignant tumor in order to test the diagnostic potential of Tc-99m tetrofosmin as a tumor imaging agent, and this agent actually showed high accumulation in the lung cancer lesion, which was comparable

to that of thallium-201. On the other hand, the retention index of the tumor, calculated from Tc-99m tetrofosmin imaging, appears to be slightly lower than that calculated from thallium-201 imaging, suggesting that the uptake and retention mechanisms of Tc-99m tetrofosmin by cancer cells may be different from those of thallium-201. In addition, the early ratio calculated from Tc-99m tetrofosmin imaging is higher than the delayed ratio, suggesting that early imaging with Tc-99m tetrofosmin may be the better choice to detect the lung cancer in practice. But the precise uptake mechanisms of this tracer, by cancer cells, have not yet been elucidated. Furthermore, it is unclear whether this agent is useful for differentiating malignant from benign tumors. Further investigations, including basic studies and larger clinical trials, are therefore needed to clarify the potentials of this tracer for tumor imaging. Nevertheless, our case clearly showed an uptake of Tc-99m tetrofosmin in the lung lesion, which was comparable to that of thallium-201, and we think that this preliminary report justifies further evaluation with this agent for assessing lung cancer.

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