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FDG PET in solitary metastastic/secondary tumor of the kidney: a report of three cases and a review of the relevant literature

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Metastatic tumors or secondary lymphoma of the kidney are rare and can often be missed on conventional computed tomography (CT) imaging. On the other hand, many types of metastatic tumor or lymphoma can be detected clearly as hotspots of elevated uptake on FDG PET. However, excreted FDG present in the urinary tract mimics these findings and interferes with image reading. Careful investigation of the renal cortex by FDG PET and review of anatomical images, such as the findings of CT and MRI, have important roles in the detection of renal tumor. Here, we present three cases of solitary metastatic/secondary tumor of the kidney, and discuss the features of the lesions on FDG PET in comparison with their appearance on CT.

Key words: FDG, PET, renal metastasis

INTRODUCTION

CLINICALLY, metastatic tumors or secondary lymphoma of the kidney are uncommon, and therefore there has been little opportunity to detect them on conventional CT. Moreover, CT diagnosis of renal metastasis or lymphoma is difficult, especially in cases with only a single small lesion. There have been extensive studies of the use of positron emission tomography (PET) with ^{18}F-2-fluoro-2-deoxy-glucose (FDG) in the evaluation of malignant tumors. Many types of metastatic tumor can be seen clearly as regions showing increased uptake on FDG PET, but excreted FDG in the urinary tract mimics abnormal findings in the kidney.[1] Here, we present three cases of solitary metastatic/secondary tumor of the kidney, and discuss the features of the lesions on FDG PET in comparison with the appearance on CT. To our knowledge, there have been no previous reports of the evaluation of metastatic/secondary tumor of the kidney on FDG PET.

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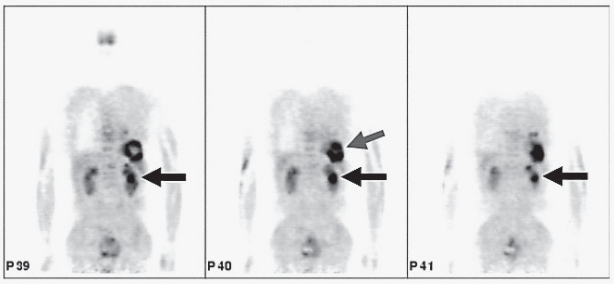
METHODS

PET scans were obtained with a Siemens EXACT HR$^+$ scanner (Siemens, Knoxville, TN, USA), using a full width at half maximum of 4.5 mm and a 15-cm transaxial field of view. Patients were asked to fast for 4 h prior to the scan. Whole-body acquisition was begun 60 min after injection of 185 MBq of ^{18}F-FDG. Emission data were collected at 2 min per frame position in three-dimensional mode. Transmission scans were obtained before emission scans with ^{68}Ge rod sources. Reconstruction of both transmission and emission scans used accelerated maximum-likelihood reconstruction and ordered-subset expectation maximization. Standardized uptake values (SUV) were also calculated.

Case 1

A 75-year-old man with lung cancer and mediastinal lymph node metastasis was referred to our hospital. The clinical stage of the disease was estimated as T4N2M0 before FDG PET. Subsequently, FDG PET (Fig. 1A) detected a hotspot (SUVmax 6.3) in the left kidney. Despite the low level of activity in the renal collecting system, very high activity levels were seen in the middle of the left kidney (*black arrow*). Left lung cancer was seen as a ring-like area of high uptake (*gray arrow*). Enhanced



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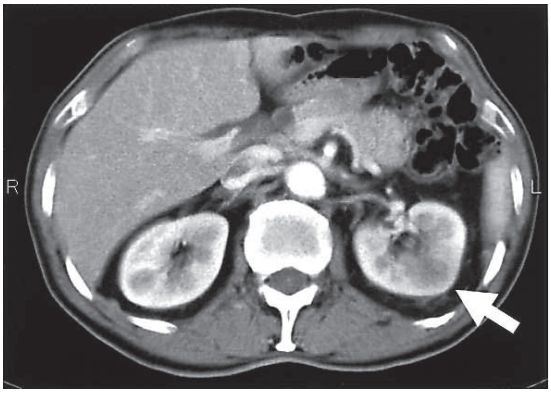


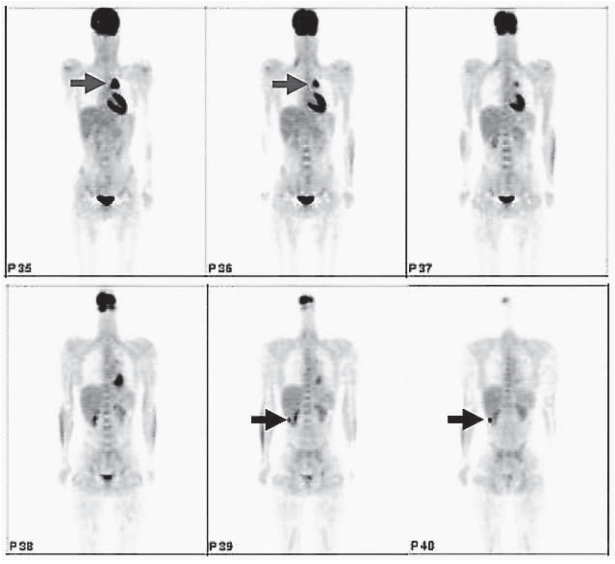
B

Fig. 1 A 75-year-old man with lung cancer and mediastinal lymph node metastasis. FDG PET (A) detected a hotspot (SUVmax 6.3) in the left kidney (*black arrow*), suggesting renal metastasis. Left lung cancer was seen as a ring-like area showing high uptake (*gray arrow*). Enhanced CT (B) indicated a partially thinned renal cortex with an adjacent ill-defined lesion showing low enhancement (*white arrow*).

CT (Fig. 1B) demonstrated a partially thinned renal cortex and adjacent ill-defined lesion showing low enhancement (*white arrow*). This finding was missed on CT, but examination of PET images revealed the lesion to be a metastatic tumor. Despite chemotherapy, follow-up CT performed three months later showed no significant changes in the size of either the lung or renal tumor.

Case 2

A 15-year-old boy with mediastinal malignant lymphoma was referred to our hospital. After six cycles of r-CHOP chemotherapy (cyclophosphamide, doxorubicin, vincristine, prednisone, and rituximab), the primary tumor showed marked regression but did not disappear completely. FDG PET (Fig. 2A) was performed and showed abnormal high uptake in the mediastinum (*gray arrow*), suggesting a residual viable tumor. Moreover, an additional hotspot was detected in the right kidney (*black arrow*). The hotspot was located peripherally, separate from the collecting system. Enhanced CT (Fig. 2B) revealed a small lesion showing low enhancement in the well-enhanced renal cortex (*white arrow*). This lesion looked like a small cyst and was missed on CT diagnosis. However,



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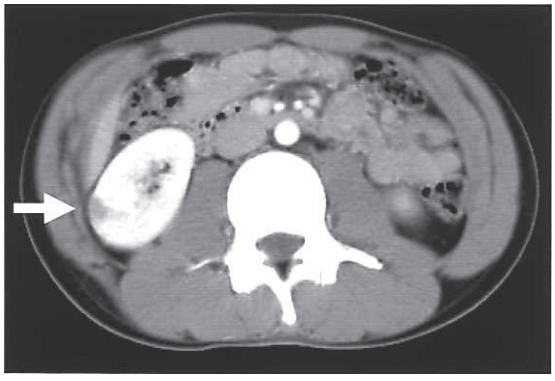


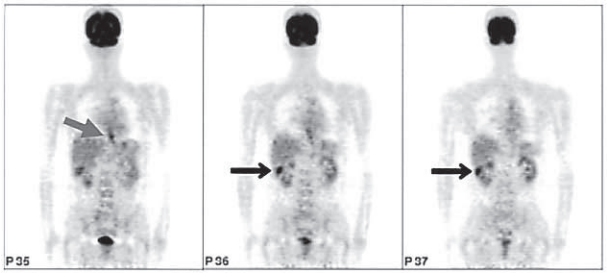
B

Fig. 2 A 15-year-old boy with mediastinal malignant lymphoma after six cycles of chemotherapy. FDG PET (A) showed hotspots in the mediastinum (*gray arrow*) and in the right kidney (*black arrow*), located peripherally and separated from the collecting system. Enhanced CT (B) revealed a small lesion showing a low level of enhancement in the well-enhanced renal cortex (*white arrow*).

PET scan revealed the lesion to be a metastatic tumor. Chemotherapy and autologous peripheral blood stem cell transplantation were performed in this patient. The lesion in the right kidney was found to have disappeared on both follow-up CT and FDG PET performed four months later, suggesting a good response to treatment.

Case 3

A 44-year-old man with malignant melanoma in the esophagus was referred to our hospital for treatment. FDG PET (Fig. 3A) revealed abnormal hotspots in the esophagus (*gray arrow*) and the right kidney (*black arrow*). The hotspot in the right kidney (SUVmax 5.8) was located peripherally, and was separate from the collecting system. Enhanced CT (Fig. 3B) revealed a well-defined



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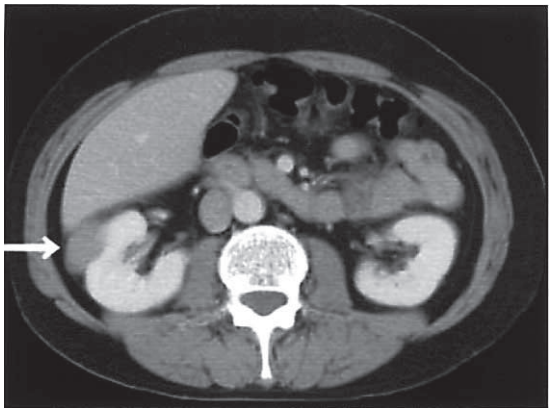

B

Fig. 3 A 44-year-old man with malignant melanoma in the esophagus. FDG PET (A) revealed abnormal hotspots in the esophagus (*gray arrow*) and the right kidney (*black arrow*). Enhanced CT (B) revealed a well-defined poorly enhanced lesion protruding from the renal cortex (*white arrow*).

poorly enhanced lesion protruding from the renal cortex (*white arrow*). This finding was not recognized as metastasis on CT diagnosis, but was reassessed as a metastatic lesion based on examination of PET images. This patient was administered chemotherapy and radiation for lesions in the esophagus and the right kidney, and follow-up CT performed two month later revealed slight regression of both lesions.

DISCUSSION

Metastasis to the kidney has been found at autopsy in 7–20% of patients with cancer.[2–4] Lymphomas and carcinomas of the lung, breast, stomach, pancreas, and colon were the tumors found most commonly to have metastatic or secondary tumor in the kidney.[5–8] Renal metastases are generally small, bilateral, and multifocal lesions.[8,9] Moreover, it was reported previously that all patients who were found to have metastases to the kidney showed evidence of clinical progression or radiographic evidence of other metastases from their non-renal malignancy.[10] In these cases, diagnosis of renal metastases on CT is not difficult. However, detection of a small and solitary metastatic lesion is almost impossible on plain CT, and is difficult to distinguish from a benign cystic mass even on enhanced CT. In addition, a newly detected renal metastatic or secondary tumor is important clinically as both the staging and therapeutic strategy must be altered accordingly.

One of the main reasons for interest in FDG PET is its ability to detect metastatic lesions that would otherwise be missed on conventional imaging or that are located in clinically hidden or difficult areas.[11] FDG PET has been reported to detect unexpected extrathoracic metastases in 11–15% of patients with lung cancer without any evidence of metastases after conventional staging.[12–14] In the cases described in the present report, the renal lesions were missed on CT, which was performed prior to FDG PET. On CT screening, multiphase scans of the kidney are not performed and wide collimation is used, making it difficult to detect and evaluate small renal masses.

Among the primary tumors that are the most common sources of metastatic or secondary tumor of the kidney, lymphoma, lung cancer, colon cancer and so forth show particularly intense FDG activities. Metastatic or secondary tumors from these types of malignancy can also be detected clearly on FDG PET. Although excreted FDG in the urinary tract interferes with image reading, careful investigation of the renal cortex can potentially detect metastatic lesions. Previous reports demonstrated the utility of hydration on FDG PET for eliminating image artifacts originating from the kidneys.[15] Hydration is not performed routinely in our institution, but it might be useful for detecting metastatic or secondary tumor of the kidney.

In cases in which a hotspot is detected in the renal cortex, it is necessary to review anatomical images, such as the findings of CT and MRI. A renal mass detected on CT corresponding to the hotspot on FDG PET is very likely to be a metastatic or secondary tumor, even if it appears to be a benign cyst on CT. However, this might not be the case if the primary tumor is not FDG-avid. Moreover, it is also necessary to consider the possibility of renal cell carcinoma (RCC), because FDG PET shows low sensitivity for the detection of RCC.[16]

Our study was limited in that histological confirmation could not be obtained in all cases. Several previous studies have evaluated the utility of renal mass biopsy for evaluation of an indeterminate mass.[17,18] However, in the cases described here, integrated analyses by PET and CT as well as the examination of the patients' clinical courses indicated that the lesions were likely to be renal metastases. Moreover, there have been previous reports of tumor needle tract seeding,[19–21] associated morbidity,[22,23] and false-negative results as high as 15%.[23,24] Therefore, percutaneous biopsy of the kidney is not performed routinely in our hospital.

CONCLUSIONS

Solitary renal metastasis is often missed on examination by CT. In many cases, FDG PET can visualize such

lesions as hotspots, but excreted FDG in the urinary tract interferes with image reading. However, careful investigation of the renal cortex by FDG PET and review of anatomical images, such as CT and MRI findings, have important roles in the detection of solitary renal metastasis.

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