Case Report

Distant Metastasis of Prostate Cancer: Early Detection of Recurrent Tumor with Dual-Phase Carbon-11 Choline Positron Emission Tomography/Computed Tomography in Two Cases

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Several types of recurrence may be detected by radiologic assessment after treatment in patients with prostate cancer. However, early detection of distant metastasis using positron emission tomography has so far never been published. We report two patients who underwent hormone therapy or surgical resection for prostate cancer. They developed distant metastases which were detected on whole body [C-11] choline positron emission tomography/computed tomography with significant elevation of serum PSA level. In one patient, recurrent tumor of the supraclavicular node (6 mm) diminished in size after subsequent hormone therapy. Surgical resection of recurrent tumor of the lung (12 mm) was performed in the other patient, the pathology of which confirmed the metastatic adenocarcinoma derived from the prostate. The recurrent tumor can be correctly detected by dual-phase whole body [C-11] choline positron emission tomography/computed tomography.

Key words: prostate cancer – carbon-11 choline – positron emission tomography – computed tomography

INTRODUCTION

Prostatic specific antigen (PSA) has become the gold standard for monitoring many patients with prostate cancer after treatment. However, early detection of recurrent tumor is often difficult even if significant elevation of serum PSA level is present, the failure of which is responsible for significant morbidity and mortality. Various radiologic modalities can be used for early detection of recurrent disease during the post-operative course. Cross-sectional imaging of whole body computed tomography, locoregional assessment by ultrasound or magnetic resonance imaging, and whole body bone scan may often reveal recurrent tumor when the elevation of serum PSA is observed during the follow-up (1). On the other hand, early detection of distant metastasis other than bone metastasis by means of radiologic evaluation has not been published so far. The aim of this study is to report two cases of patients with prostate cancer in whom the recurrent tumors of the supraclavicular node or lung could be correctly detected using dual-phase whole body [C-11] choline positron emission tomography/computed tomography.

CASE 1

A 71-year-old man, suffering from prostate cancer, had been followed-up by monitoring serum PSA level (normal level: 0–2.7 ng/ml) after the initial diagnosis. Radical prostatectomy was performed on March 2001 and clinical stage was T2bN0M0. Up to July 2005, serum PSA level remained stable as compared with the post-operative status. Other hematologic and basic biochemical parameters were within normal limits. The level of serum PSA rose to 4 ng/ml in January 2006. The computed tomography scan of the abdomen and pelvis did not demonstrate any features of recurrent tumors. The computed tomography scan of the thorax disclosed a small nodular lesion in the left upper lobe of the lung and areas of increased attenuation in the left lower lobe of the lung. By comparison with the previous computed tomography scan, a slight increase...
in the size of the nodule in the left upper lobe was noted. He underwent a whole body [C-11] choline positron emission tomography/computed tomography in January 2006. Emission scans from pelvis were obtained starting 5 min after IV administration of 444.8 MBq of [C-11] choline and subsequent scans from the base of the skull to the mid thigh were obtained after 14 min uptake time. The images showed abnormal [C-11] choline accumulation in the small nodule of the left upper lobe (Fig. 1a). The maximal standardized uptake value (SUV) of the small nodule was 3.84 at 14 min after IV administration of [C-11] choline. Because of the high sensitivity of significant [C-11] choline uptake to thoracic malignancies, the possibility of concomitant lung cancer or recurrent prostate cancer was considered. Additional imaging findings included slight accumulation of [C-11] choline to the pelvic floor and left iliac node (arrow).

Figure 1. Carcon-11 choline positron emission tomography/computed tomography in a 71-year-old man suffering from prostate cancer. (a) Axial positron emission tomography/computed tomography of the chest. Abnormal uptake of [C-11] choline is observed in the small nodule of the left upper lobe (arrows). Pathologic diagnosis is metastasis of prostate cancer. (b) Axial positron emission tomography/computed tomography of the pelvis. Image shows slight accumulation of [C-11] choline to the pelvic floor and left iliac node (arrow).

were confirmed to be metastasis from prostate cancer. Histologically, the alveolar architecture was preserved with the alveolar space filled with lymphocytes and macrophages in the specimens from the left lower lobe. There was active inflammation with a mild degree of interstitial fibrosis. Histochemical staining for acid-fast bacteria or fungal organism was negative. Recovery was uneventful, and the patient was discharged 8 days after surgery.

CASE 2
A 76-year-old man presented with hematuria following a urinary discomfort. Serum PSA level was elevated significantly (22 ng/ml) and diagnostic confirmation of prostate cancer was achieved by biopsies. The computed tomography scan of the thorax and abdomen did not demonstrate any features of metastatic tumors. The computed tomography scan of the pelvis showed enlarged prostate and internal iliac node. Dual-phase whole body [C-11] choline positron emission tomography/computed tomography were performed. Emission scans from the pelvis were obtained starting at 5 min and subsequent scans from the base of the skull to the mid thigh were obtained at 14 min after injection. The images disclosed abnormal uptake in the prostate, right seminal vesicle and left bladder wall, which were considered as possible direct invasions (Fig. 2a). The maximal SUV of the primary lesion was 7.12 at 5 min and 8.65 at 14 min after the IV administration of [C-11] choline. In addition, abnormal accumulation of [C-11] choline was observed in the right supraclavicular and right iliac nodes and the maximal SUV of these nodal lesions at 14 min were 5.51 and 2.65, respectively (Fig. 2b). The results of whole body bone scan were negative. On radiological review, the possibility of T4N1M1a disease was considered. Treatment with leuprorelin acetate was started and the patient remained on its dose of 3.75 mg monthly over the next 3 months. During this period there was a significant decline in serum PSA level. Repeat computed tomography scan of the thorax, abdomen and pelvis showed minor regression of primary and nodal lesions (Fig. 2c).

DISCUSSION
Our report shows that [C-11] choline positron emission tomography/computed tomography can be used as an accurate non-invasive method for detecting distant metastasis in prostate cancer. Choline is an essential component of the cell membrane, uptake of which may be through a choline-specific transporter protein. Choline kinase, which catalyzes the phosphorylation of choline, is upregulated in prostate cancer cells (2). [C-11] choline will be phosphorylated as a choline analog by choline kinase and retained in cancer cells (3). However, precise pathway of metabolic trapping by cancer cells is still unknown, prompting further studies to clarify the mechanism of imaging by [C-11] choline.

Early detection or exclusion of distant metastasis is of high clinical importance in management of patients with
prostate cancer. Patients with distant metastasis may benefit from early introduction of hormone therapy, which can avoid unnecessary surgery. Bone metastasis, which is often associated with high-risk prostate cancer, can be detected by bone scan. However, distant metastasis other than bone metastasis is considered less sensitive to identification solely by means of conventional imaging techniques.

[C-11] choline is a characteristic biotracer for imaging prostate cancer. [C-11] choline positron emission tomography is more accurate in determining nodal stage prior to operation than conventional imaging methods (4). De Jong and co-workers reported sensitivity, specificity and accuracy for staging lymph node in prostate cancer using [C-11] choline tracer as 80, 96 and 93%, respectively (5). However, conventional cross-sectional imaging have restrictions not only for staging lymph node but for detecting distant metastasis in prostate cancer. It was shown in this study that a hybrid imaging modality, positron emission tomography/computed tomography using [C-11] choline tracer, can correctly detect distant metastasis at initial staging.

There are only limited data available on staging of prostate cancer with positron emission tomography/computed tomography. [F-18] fluorodeoxyglucose (FDG) is proposed as gold standard for primary staging of cancer imaging. However, [F-18] FDG has not met the expectations in the diagnosis of primary and metastatic prostate cancer, because the method was interfered by its low uptake in organ-confined tumor and its high background activity owing to excretion via urinary tract (6,7). In contrast, the accumulation of [C-11] choline in the pelvis is hardly affected by urinary background within the limits of short uptake time.

In summary, here we described two cases of distant metastasis of prostate cancer. A whole body [C-11] choline positron emission tomography/computed tomography permitted detection of this recurrence. This warrants further study to confirm its usefulness as imaging study at initial presentation.

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References

