



Situs Inversus Totalis on ^{18}F -FDG PET/CT: A Case Report and a Literature Review

Xu-Sheng Liu, Rui-Min Wu, Hua-Bing Wan, Yi-Jia Chen, Fan Tan, Dao-Bing Zeng, Yi Yang and Zhi-Jun Pei*

Department of Nuclear Medicine and Institute of Anesthesiology and Pain, Taihe Hospital, University of Medicine, Shiyuan, China

A 62-year-old female patient with pathologically confirmed left lung small cell neuroendocrine carcinoma. The patient was referred to our positron emission tomography (PET)/CT center to look for possible metastatic diseases. After fasting for 8 h, the fasting blood glucose level of the patient was 7.1 mmol/L. The patient was intravenously injected with a 6.42 mCi (238 MBq) ^{18}F -fluorodeoxyglucose (FDG) imaging agent. After the patient rested for 1 h, we scanned the patient with SIEMENS Biograph mCT 64 PET/CT camera. In addition to lung tumors and lymph node diseases, abnormal tracer uptake in the patient's thyroid was also found. PET/CT also showed situs inversus totalis of the patient, including the dextrocardia, liver on the left side, stomach, and spleen on the right side of the patient's body. The identification of anatomical variations and abnormalities by PET/CT imaging is very important to develop the best treatment for lung cancer.

Keywords: 18 F-FDG, PET/CT, small cell lung cancer, situs inversus totalis, neuroendocrine carcinoma

INTRODUCTION

Situs inversus totalis refers to the position of the thoracic cavity, abdominal cavity, or thoracic and abdominal cavity, which is opposite to normal and presents a mirror image with healthy people (1). This kind of patient is rare in clinics (2). It is reported that situs inversus totalis (SIT) can be associated with multiple cancers, such as breast cancer (3), esophageal cancer (4), and cervical cancer (5). Lung small cell neuroendocrine carcinoma, also known as small cell lung cancer (SCLC), is a subtype of pulmonary neuroendocrine tumors (PNETs) (6). According to the classification of who in 2015, PNETs are divided into four subtypes: typical carcinoid (TC), atypical carcinoid (AC), large cell neuroendocrine carcinoma (LCNEC), and SCLC (7). PNETs are epithelial tumors derived from pulmonary neuroendocrine cells. They have unique biological and clinical characteristics, accounting for about 20% of primary lung tumors. They are a common type of neuroendocrine tumor (NETs) (8). It is rare for the same patient to have both SIT and SCLC. Positron emission tomography (PET)/CT is a molecular imaging technology able to provide both anatomical and functional information. It can obtain cross-sectional images of the whole body in all directions, to achieve the purpose of early detection of lesions and diagnosis of diseases (9). In this study, we reported the PET/CT of patients with SIT along with SCLC as follows.

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Maria Gazzilli,
Civil Hospital of Brescia, Italy

*Correspondence:

Zhi-Jun Pei
pzjzml1980@taihehospital.com

Specialty section:

This article was submitted to
Nuclear Medicine,
a section of the journal
Frontiers in Medicine

Received: 24 January 2022

Accepted: 07 February 2022

Published: 09 March 2022

Citation:

Liu X-S, Wu R-M, Wan H-B, Chen Y-J,
Tan F, Zeng D-B, Yang Y and Pei Z-J
(2022) Situs Inversus Totalis on
 ^{18}F -FDG PET/CT: A Case Report and
a Literature Review.
Front. Med. 9:840795.
doi: 10.3389/fmed.2022.840795

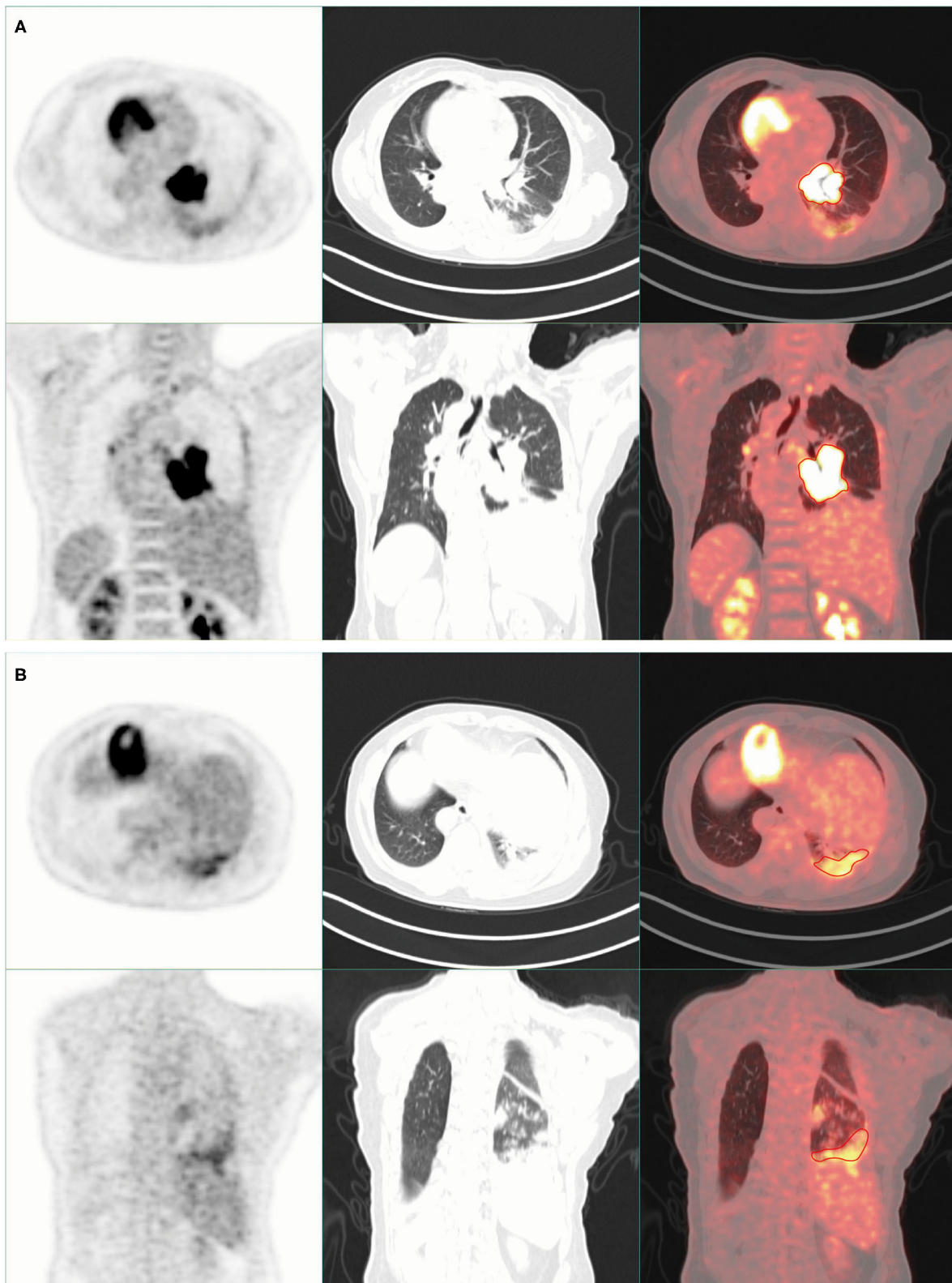
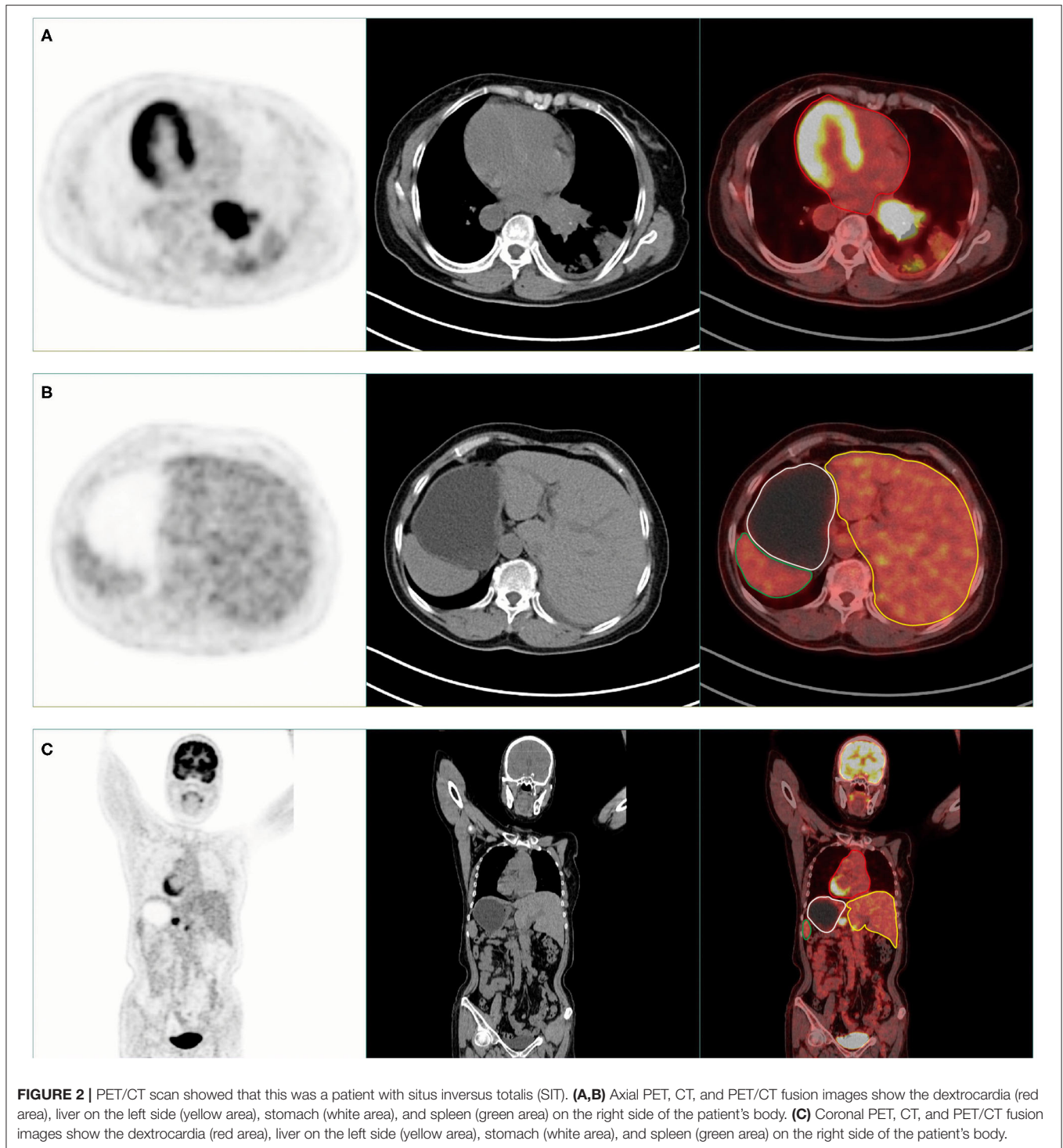


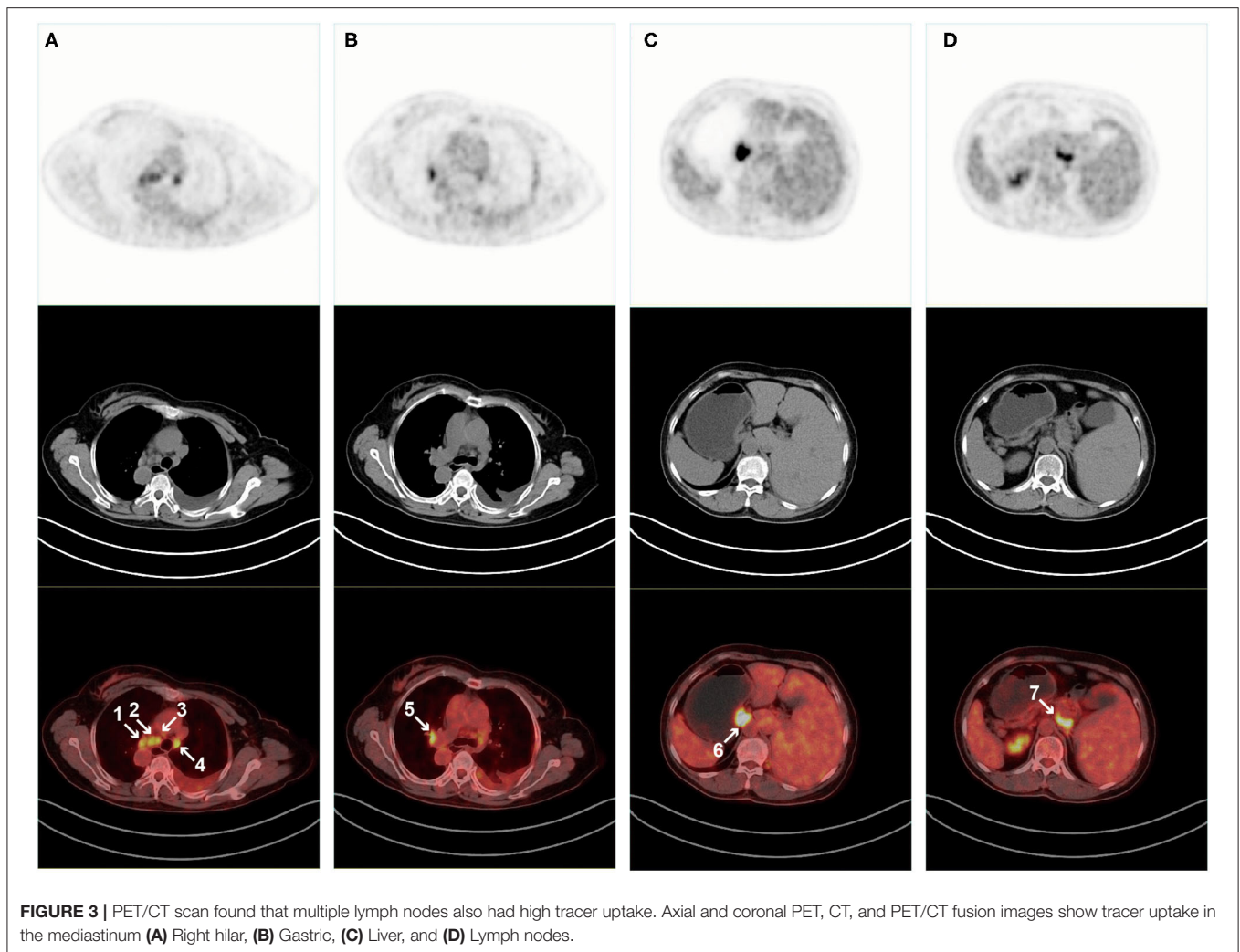
FIGURE 1 | Chest imaging of positron emission tomography (PET)/CT scan. **(A)** There was high tracer uptake in the left hilar area. **(B)** The bronchus of the lower lobe of the left lung was truncated, and high tracer uptake was observed.



CASE PRESENTATION

A 62-year-old woman was admitted with a cough with intermittent coughed blood. The main performance is no obvious inducement of cough, mainly obvious at night, the weight loss of 10 kg within half a month. The patient's cough has worsened

in the past day with hemoptysis. CT scan showed central lung cancer with obstructive pneumonia in the lower lobe of the left lung, and SIT was also found. The serum ferritin level was 300.73 ng/ml and the carbohydrate antigen CA125 level was 132.8 μ /ml. The pathological results of bronchoscopy biopsy confirmed that it was small cell neuroendocrine carcinoma of the



lung [immunohistochemical results: CK (P) (+), CD56 (+), Cg-A (+), CK7 (-), P63 (-), P40 (-), Ki-67 (90%+), TTF-1(SPT24) (+), and Syn (+)]. The patient was referred to our department for an ^{18}F -fluorodeoxyglucose (FDG) PET/CT examination.

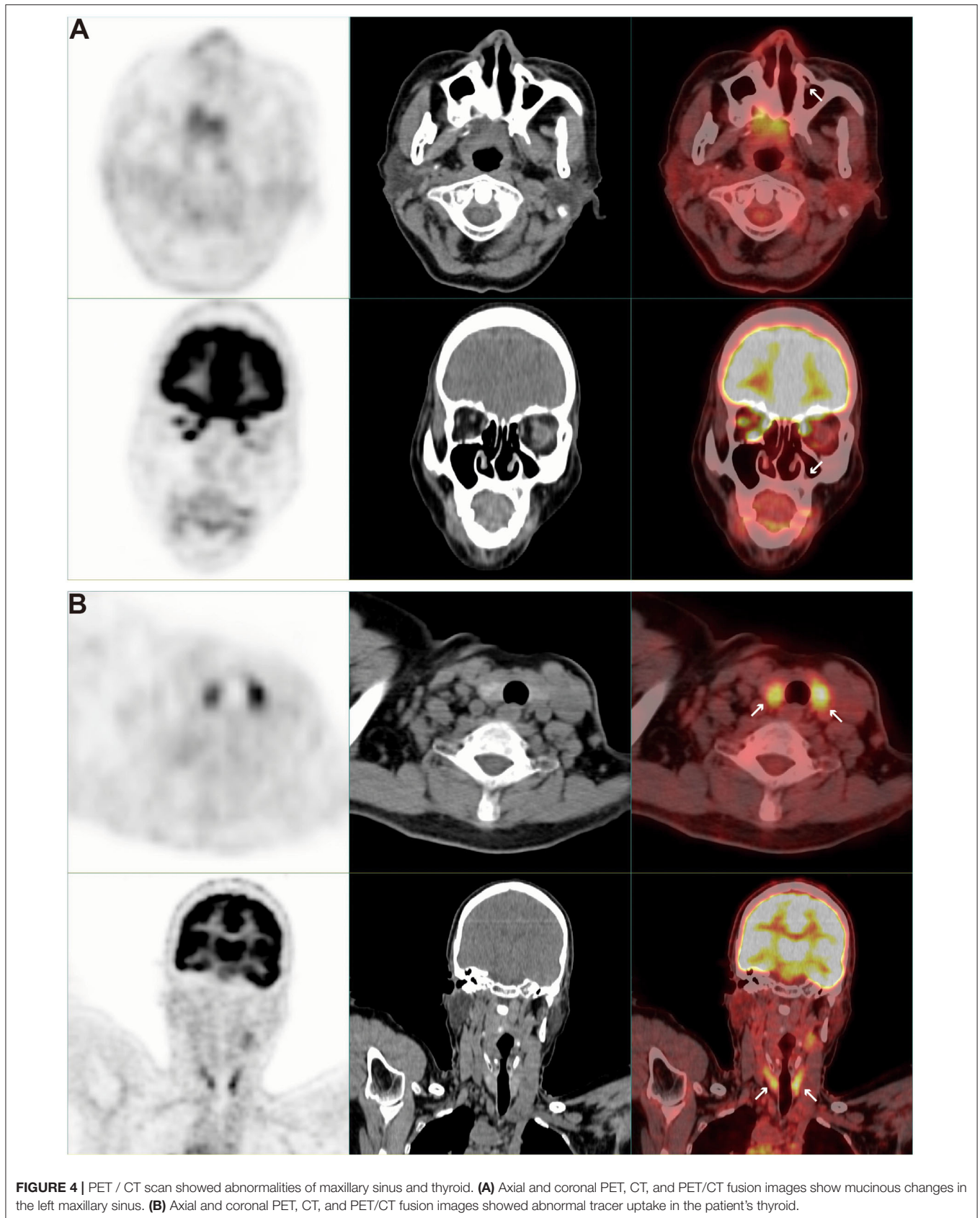
The PET/CT (SIEMENS Biograph, Germany) scan results showed high tracer uptake in the left hilar area (Figure 1A). The bronchus of the lower lobe of the left lung was truncated and significant uptake of tracer was observed (Figure 1B). The results of this scan were consistent with those of CT scan and pathological examination. An interesting phenomenon was found when observing the whole-body PET/CT scanning images of patients. PET/CT scan showed that this was a patient with SIT. The imaging of the heart, liver, stomach, and other organs in the patient is completely opposite to that in the normal person (Figure 2).

In addition to the known high tracer uptake in left lung tumors, PET/CT scan also found high tracer uptake in multiple lymph nodes. These lymph nodes were distributed in the mediastinum (Figure 3A), right hilum (Figure 3B), stomach (Figure 3C), and liver (Figure 3D). At the same time, we also found mucinous changes in the patient's left maxillary sinus, and

its tracer uptake was slightly increased (Figure 4A). However, PET/CT showed no significant change in thyroid density, but the tracer uptake was abnormally increased (Figure 4B). However, the levels of thyroid-stimulating hormone (TSH, 4.57 mIU/L, 0.4–5), triiodothyronine (T3, 1.83 nmol/L, 1.07–2.6), thyroxine (T4, 117.46 nmol/L, 69–161), free triiodothyronine (FT3, 4 pmol/L, 2.76–7.65), and free thyroxine (FT4, 8.09 pmol/L, 7.98–16.02) in the patient's serum were within the normal range. Laboratory examination also found that the contents of alanine aminotransaminase (ALT, 47.3 U/L, 0–40), aspartate aminotransaminase (AST, 53.7 U/L, 0–35), γ -glutamyltransferase (GGT, 112 U/L, 0–45) and alkaline phosphatase (ALP, 157.6 U/L, 50–135) in the patient's serum were significantly increased, but PET/CT scan did not find obvious abnormalities in the liver.

DISCUSSION

Situs inversus totalis (SIT), is a rare congenital anomaly, represents a complete left to right side transposition of the



asymmetrical thoracic and abdominal organs, and incorporates dextrocardia (1, 3). As shown in this case, simultaneous abnormalities in the respiratory and lymphatic system often complicate SIT cases. Interestingly, the occurrence of lung small cell neuroendocrine carcinoma in patients with SIT is extremely rare. This is the first reported case of SCLC, lymph node metastasis, and SIT.

Although surgical resection is a common method for SCLC treatment, it is more difficult to stage and treat SCLC after SIT and lymph node metastasis. PET/CT not only has the characteristics of high spatial resolution and clear anatomical structure of CT but also has the advantages of PET functional imaging. At the same time, PET/CT scan can also provide information about whether there is metastasis in various organs of the whole body and provide strong evidence for the accurate staging of tumors (9).

It is well known that SIT, bronchiectasis, and sinusitis are typical features of Kartagener syndrome. Kartagener syndrome complicated with lung cancer has also been reported before (10). Although there is no pathological evidence of bronchiectasis, in this case, careful examination is still needed before the operation to rule out the possibility of Kartagener syndrome. At the same time, if surgical treatment is required, surgeons need to be very careful about SIT to avoid errors. Although SIT has been reported with solid tumors (1, 3–5, 11), whether an association between SIT and malignancies has been controversial, and further clinical and epidemiological research evidence is needed due to objective

limitations such as the number of cases. It is also necessary to see if malignant metastases already exist when developing treatment options for patients with SIT with tumors. PET/CT scanning is very important to identify the abnormal biological distribution of tracers and observe anatomical variation, so as to help clinicians formulate the best treatment strategy for patients.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

X-SL conceived the project and wrote the manuscript. X-SL, R-MW, and H-BW performed image acquisition and prepared images. X-SL, Y-JC, FT, D-BZ, and YY participated in the discussion and language editing. Z-JP reviewed the manuscript. All authors contributed to the article and approved the submitted version.

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