# An old enemy not to be forgotten during PET CT scanning of cancer patients: tuberculosis

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**Aim of the study:** Positron emission tomography–computed tomography (PET CT) scan is commonly used in current medical oncology practice as an imaging method. In this study we present data from cancer patients who were followed at our clinic and suspected of having tuberculosis during PET CT scanning. After the biopsy, they were diagnosed with concomitant tuberculosis.

**Material and methods:** In this study, 14 patients who applied to our clinic and followed up due to cancer, and had PET CT scanning for the preliminary staging or further evaluation, were included. The patients were diagnosed with metastatic or recurrent disease, and their biopsy results revealed tuberculosis.

**Results:** The mean age was 57.8 years with SD (standard deviation) 13.1 years and gender distribution of 78.6% ($n = 11$) females and 21.4% ($n = 3$) males. None of the patients had tuberculosis in their personal history (0%). Among the patients, 5 (35.7%) were diagnosed with tuberculosis during the preliminary staging, whereas 9 (64.3%) were diagnosed during the follow-up after the treatment. The median time to tuberculosis diagnosis was 11 months (min–max: 3–24 months) after the treatment. The most commonly involved lymph nodes during PET CT scanning were mediastinal in 8 (64.3%), axillary in 3 (21.4%) and para-aortic in 3 (21.4%) patients. The mean $SUV_{max}$ (maximum standardised uptake value) of lymph node involved by PET CT scanning was defined as 8.5 (SD 2.6).

**Conclusions:** Despite all improvements in modern medicine, tuberculosis is still a serious public health problem. It should always be considered in differential diagnosis while evaluating PET CT scanning results of cancer patients, because it may cause false positive results.

**Key words:** cancer, PET CT, tuberculosis.

## Introduction

One of the most important issues in patients diagnosed with cancer is the staging after pathological diagnosis. Appropriate staging at the time of diagnosis is one of the most important factors determining the follow up and treatment process, and also the prognosis of the disease [1]. Moreover, rebiopsy of suspected lesions according to positron emission tomography–computed tomography (PET CT) scanning to determine the nature of the lesion in cancer patients during treatment or follow up periods is the recommended method for rational patient management. Imaging methods (CT, magnetic resonance imaging – MRI) have commonly been used for staging and follow up, and PET CT scanning, which has extensively been used in the clinical setting in the last decade, aroused high expectations because of its high sensitivity and specificity, but later it was realised that this examination method should be used more carefully due to its potential for false positivity and negativity [2]. False positivity conditions are physiological involvements, infections (specific infections), inflammations (soft tissue trauma, collagen tissue diseases) and granulomatous infections (sarcoidosis, tuberculosis) [3–7]. Although tuberculosis, a chronic problem as old as human history, was once a problem mainly for low socioeconomic populations, it has evolved into a rising problem in developed countries because of acquired immuno-suppression conditions (AIDS, haematological and solid organ cancers, medical conditions requiring immunosuppressive treatments). In this present study we presented data from cancer patients who were followed at our clinic and suspected of having tuberculosis during PET CT scanning. After the biopsy, they were diagnosed with concomitant tuberculosis.

## Material and methods

A total of 14 patients, who applied to our clinic and were followed up due to cancer, and had PET CT scanning for the preliminary staging or further evaluation, were included in this present study. The patients were diagnosed with metastatic or recurrent disease, and their biopsy results revealed tuberculosis. Fine needle aspiration technique was used to perform lymph node biopsies from patients suspected of having tuberculosis. Pathological cancer diagnoses had already been made in all enrolled patients. Demographic, laboratory, pathological and nuclear imaging results of all patients were recorded. Statistical analysis was performed by using the SPSS for Windows 15.0 (Statistical Package for Social Sciences) package program. Both descriptive and analytical statistics were used.

## PET/CT technique

The patients were imaged using a dedicated PET/CT system (Discovery-STE 8; General Electric Medical System, Milwaukee, WI). The patients fasted for at least 6 hours before intravenous administration of 370 to 555 MBq (10–15 mCi) 18F-FDG. Pre-injection blood glucose levels were measured to ensure that they were below 150 mg/dl. During the distribution phase, the patients lay supine in a quiet room. Combined image acquisition began 55–65 minutes after FDG injection. First, an unenhanced CT scan (5-mm slice thickness) from the vertex of the skull to the inferior border of the pelvis was acquired using a standardised protocol (140 kV and 80 mA). The subsequent PET scan was acquired in the 3-dimensional mode (3 minutes per bed position) without repositioning the patient on the table. Computed tomographic and PET images were acquired with the patient breathing shallowly. Attenuation was corrected using the CT images.

## Results

A total of 14 patients were included in the study. Clinical and demographic characteristics of patients are shown in Table 1. The mean age was 57.8 (SD 13.1) years. Of the included patients, 11 (78.6%) were females and 3 (21.4%)

were males. None of the patients had tuberculosis in their personal history (0%). When tuberculosis in the family history was asked about, the history was positive in 3 (21.4%) of the patients. The distribution of cancer diagnosis was gastric cancer in 3 (21.4%) patients, endometrium cancer in 2 (14.3%) patients, rectum cancer in 2 (14.3%) patients, cervical cancer in 2 (14.3%) patients and hepatocellular carcinoma, hodgkin's lymphoma and breast, pancreas and prostate cancers in 1 patient (for each) (7.1%). Among the patients, 5 (35.7%) were diagnosed with tuberculosis during the preliminary staging, whereas 9 (64.3%) were diagnosed during the follow-up after the treatment. Mediastinal lymph nodes were affected lymph nodes in patients at preliminary staging. The median time to tuberculosis diagnosis was 11 months (min-max: 3–24 months) after

**Table 1.** Patient characteristics and demographic features

| Parameter | | Value |
|---|---|---|
| Mean age (SD) | | 57.8 (13.1) |
| Gender (%) | female | 11 |
| | male | (78.6%) |
| | | 3 (21.4%) |
| Family history of TBC infection | | 3 (21.4%) |
| Main diagnosis of patients | gastric cancer | 3 (21.4%) |
| | endometrium cancer | 2 (14.3%) |
| | rectal cancer | 2 (14.3%) |
| | cervical cancer | 2 (7.1%) |
| | hepatocellular cancer | 1 (7.1%) |
| | Hodgkin lymphoma | 1 (7.1%) |
| | breast cancer | 1 (7.1%) |
| | pancreas cancer | 1 (7.1%) |
| | prostate cancer | 1 (7.1%) |
| Tuberculosis diagnosis time | initial evaluation | 5 (35.7%) |
| | follow-up | 9 (64.3%) |

**Table 2.** Laboratory and PET CT findings of patients

| Parameter | | Value |
|---|---|---|
| Erythrocyte sedimentation (SD) | | 41.8 (22.4) |
| C-reactive protein (SD) | | 14.4 (5.4) |
| PET CT SUV max uptake value (SD) | | 8.5 (2.6) |
| | mediastinal lymph nodes | 9.5 (2.2) |
| | para-aortic lymph nodes | 6.4 (2.3) |
| | axillary lymph nodes | 6.9 (3.6) |
| Affected lymph node areas in PET CT | mediastinal lymph nodes | 8 (64.3%) |
| | para-aortic lymph nodes | 3 (21.4%) |
| | axillary lymph nodes | 3 (21.4%) |
| Lymph node size (SD) | mediastinal lymph nodes | 25.6 (2.1) |
| | para-aortic lymph nodes | 26.3 (1.5) |
| | axillary lymph nodes | 15 (3.5) |



**Fig. 2.** PET CT images of patients



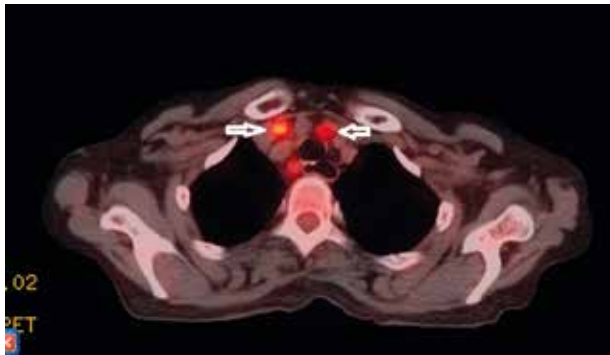**Fig. 1.** PET CT images of patients

**Fig. 3.** PET CT images of patients

the treatment. The most commonly involved lymph nodes during PET CT scanning were mediastinal in 8 (64.3%), axillary in 3 (21.4%) and para-aortic in 3 (21.4%) patients. Mean values for erythrocyte sedimentation, C-reactive protein and SUV max at involved lymph nodes detected by PET CT scanning were defined as 41.8 (SD 22.4), 14.4 (SD 5.4) and 8.5 (SD 2.6), in reciprocal order. Laboratory and PET CT findings of patients are shown in Table 2. PET CT coronal and transverse section images of two patients with involvement are shown in Figs. 1–4.

## Discussion

Tuberculosis, which may mimic signs of metastatic malignancies, should always be considered by clinicians during differential diagnosis when evaluating patients with cancer. This condition may be encountered either as an accompanying tuberculosis infection in a patient with a malignancy, or as an infection mimicking recurrence signs during the patient follow-up. If it is not detected early in both conditions, it may be fatal for the patient. However, two of our cases (one with cervical cancer and the other with gastric cancer) had mediastinal multiple lymph nodes with high SUV max values in their follow-up PET CT scans performed after the adjuvant treatment. Initially, they were considered as recurrence cases, so they received chemotherapy. As their clinical performances deteriorated during chemotherapy, lymph node biopsy was performed and then they were diagnosed with tuberculosis. In such conditions, tuberculosis diagnosis is made mainly by microbiological and histological examinations, because none of the available imaging methods is specific for tuberculosis [8–10]. Although it is suggested that nodular FDG involvement above 2.5 should lead to malignancy with 80% sensitivity and 70% specificity in PET CT examinations, the SUV max values of involved lymph nodes were above 2.5 in all of our patients [4, 9–13]. Moreover, SUV max values relating to tuberculosis in PET CT examinations were reported as high in some studies but low in some others, published in the literature [14, 15]. Chao-Jung Chen *et al.* diagnosed tuberculosis in a patient who presented with high Ca 125 and multiple peritoneal implants resembling metastatic ovarian cancer during PET CT scan, and they showed that all signs were recovered completely after antituberculous treatment [16]. Jin Mo Goo *et al.* reported a 10-case series with pulmonary nodules and positive PET CT results. After the biopsy, they diagnosed tuberculosis,



**Fig. 4.** PET CT images of patients

and they underline that tuberculosis should always be considered in endemic regions during PET CT scan evaluations [17]. Geng Tian *et al.* reported 3 patients with abdominal tuberculosis, who had signs similar to peritoneal malignancy in PET CT scan, and they concluded that PET CT examination was not helpful to resolve the problem in such circumstances, so tissue sampling should be performed for the diagnosis [18]. In our series, tuberculosis diagnosis was made in 5 patients during the preliminary staging and in 9 patients during the follow-up, by biopsy results collected from regions suspected for malignancy in PET CT examinations. The treatment plan and follow-up were completely changed in those patients. If the number of patients reported from a single centre were projected to the general population of the country, then the size of the issue would have been quite significant. In this global world, tuberculosis is still a public health problem both for developing and developed countries. Therefore, as medical oncology specialists, we should definitely consider tuberculosis in differential diagnosis of PET CT results

In conclusion, as in most medical conditions, the physician's suspicion retains its specific and sensitive value in evaluating PET CT results so as not to miss the old enemy, tuberculosis, in patients with malignancies, despite all the improvements that have been seen in modern medicine.

*The authors declare no conflicts of interest.*

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