

A Case of ^{18}F -FDG PET/CT Imaging of Kidney Metastases in Papillary Thyroid Carcinoma

Hongkun Yu, Jian Gong *

Department of Nuclear Medicine, The First Affiliated Hospital of Jinan University, No. 613, West Huangpu Avenue, Tianhe District, Guangzhou, Guangdong, 510632, China

* Corresponding author: Jian Gong

Abstract: A 60-year-old male patient underwent a PET/CT scan at our hospital one month ago, which revealed a lesion in the right kidney. Four years ago, he had radical surgery for thyroid cancer and neck lymph node dissection at another hospital, with postoperative pathology confirming papillary thyroid carcinoma. Physical examination revealed no palpable masses in the bilateral renal regions, and no tenderness or percussion pain was detected. Laboratory tests indicated the patient had mild anemia and slight renal function abnormalities. CT scan showed a round isodense lesion in the upper pole of the right kidney, measuring approximately 1.8×1.3 cm, with mild to moderate enhancement on contrast scans, appearing to have ring-like enhancement; CT diagnosis: lesion in the upper pole of the right kidney, considering the medical history, metastatic tumor was suspected. The ^{18}F -FDG PET/CT scan showed an isodense nodule in the upper pole of the right kidney, measuring approximately 2.4×1.5×1.8 cm, with increased FDG uptake, maximum SUV of 19.4; PET/CT diagnosis: isodense nodule in the right kidney with increased glucose metabolism, suggesting renal metastasis. After admission, the patient underwent a laparoscopic partial nephrectomy of the right kidney at our hospital. Postoperative pathology revealed tumor cells exhibiting a branching papillary pattern, rich in colloid tissue, abundant eosinophilic cytoplasm, variable nuclear size, irregular nuclear shape, and glassy degeneration, all of which are characteristics of metastatic papillary thyroid carcinoma. Based on the medical history, various clinical examination results, and postoperative pathology findings, the right kidney mass was ultimately diagnosed as a rare distant metastasis of papillary thyroid carcinoma—metastasis of papillary thyroid carcinoma to the right kidney.

Keywords: Thyroid Papillary Carcinoma; Renal Secondary Malignant Tumor; Positron Emission Tomography-Computed Tomography; Fluorodeoxyglucose.

1. Introduction

Papillary Thyroid Carcinoma (PTC) is the most common malignant tumor of the thyroid gland, accounting for 80%-90% of all thyroid cancers [1], originating from the thyroid gland's follicular or parafollicular epithelial cells. The incidence rate is higher in females [2] and can be developed in all ages, but it is common in young adults aged 30-50. Clinical manifestations are mostly painless nodules or masses on one side of the thyroid gland, with slow growth, and the 10-year survival rate can reach more than 90% after standardized surgical resection at an early stage [3]. However, PTC is prone to regional lymph node metastasis [4], but distant metastasis is relatively rare, with lungs and bones as the main sites of metastasis [5], while renal metastasis is extremely rare. The metastatic pattern of thyroid cancer directly affects the prognosis. Regional lymph node metastasis is common, but it can be effectively controlled by surgery combined with radioactive iodine (^{131}I) treatment, and the 5-year survival rate is still higher than 95%. In contrast, distant metastasis significantly worsens the prognosis, the 5-year survival rate of patients with lung metastasis decreases to 50%-70%, bone metastasis further decreases to 30%-50%, and brain metastasis has a very poor prognosis [6].

In this case, by analyzing the clinical manifestations and ^{18}F -FDG PET/CT imaging features of renal metastasis of thyroid cancer, we aimed to improve the recognition of such rare metastases. Studies have shown that PET/CT has a sensitivity of 85%-90% for distant metastases of thyroid cancer [7], which can effectively reduce missed diagnosis; at the same time, attention needs to be paid to the differentiation

from primary renal tumors (e.g., clear cell carcinoma of the kidney) (e.g., immunohistochemical detection of markers such as Tg and PAX8).

2. Materials and Methods

Patient, male, 60 years old. He visited the doctor after he "discovered a mass in the right kidney for over a month." More than a month ago, the patient underwent a PET/CT examination at our hospital for a follow-up after thyroid cancer surgery, which indicated a round isodense nodule in the upper pole of the right kidney. The patient has no lumbar pain, hematuria, urinary frequency, urgency, or dysuria and has no chills, fever, nausea, vomiting, dizziness, or headaches. For further treatment, he visited the urology outpatient department of our hospital and was admitted with a diagnosis of "right renal mass."

The patient's general health status has been poor; four years ago, he underwent radical thyroid cancer surgery and neck lymph node dissection at another hospital, with postoperative pathology results indicating papillary thyroid carcinoma and metastasis to the right cervical lymph nodes. More than two months ago, the patient underwent bronchoscopy at an outside hospital due to a small amount of hemoptysis, considering it was caused by bleeding from an intrabronchial mass, but the details were unclear. Since the onset of the disease, the patient's spirit, appetite, and sleep have been acceptable, bowel and bladder functions are normal, and there has been no significant weight loss.

After admission, the patient actively completed various examinations. Physical examination: No abnormal masses were palpated in both renal areas, and there was no tenderness

or percussion pain in both renal areas; no tenderness in the course of both ureters; the bladder was not distended, and no abnormal masses were palpated upon pressure, with no tenderness or rebound tenderness; no abnormal secretions at the urethral orifice; surgical scars were visible in the neck; no significant abnormalities were found in other physical examinations. Laboratory tests: Blood Routine: RBC $3.99 \times 10^{12}/L$ ($4.3 \sim 5.8 \times 10^{12}/L$; the values in parentheses are the normal reference range, same below), WBC $4.43 \times 10^9/L$ ($3.5 \sim 9.5 \times 10^9/L$), Hg 113.00g/L (130~175 g/L), PLT $302.00 \times 10^9/L$ ($125 \sim 350 \times 10^9/L$); Renal function tests: creatinine 136.1 μ mol/L (57~111 μ mol/L); Liver function, coagulation function, and tumor biomarkers (AFP, CA19-9, CEA) were all normal. The CT scan showed a round isodense lesion in the upper pole of the right kidney, measuring approximately 1.8 $\times$ 1.3 cm, with mild to moderate

enhancement on contrast scans, appearing to have ring-like enhancement; CT diagnosis: lesion in the upper pole of the right kidney, considering the medical history, metastatic tumor was suspected. In order to further observe the metabolic activity of the right renal mass and to better assess the benign or malignant nature of the tumor, the patient underwent an ^{18}F -FDG PET/CT examination at our hospital's Nuclear Medicine Department PET/CT center. The ^{18}F -FDG PET/CT imaging showed: a round isodense nodule in the upper pole of the right kidney, with relatively clear boundaries, measuring approximately 2.4 $\times$ 1.5 $\times$ 1.8cm, with increased FDG uptake, SUVmax 19.4. PET/CT diagnosis: isodense nodule in the right kidney, increased glucose metabolism, considering renal metastasis (**Figure 1**). After completing relevant examinations and excluding surgical contraindications, the patient underwent a laparoscopic partial nephrectomy of the right kidney at our hospital.

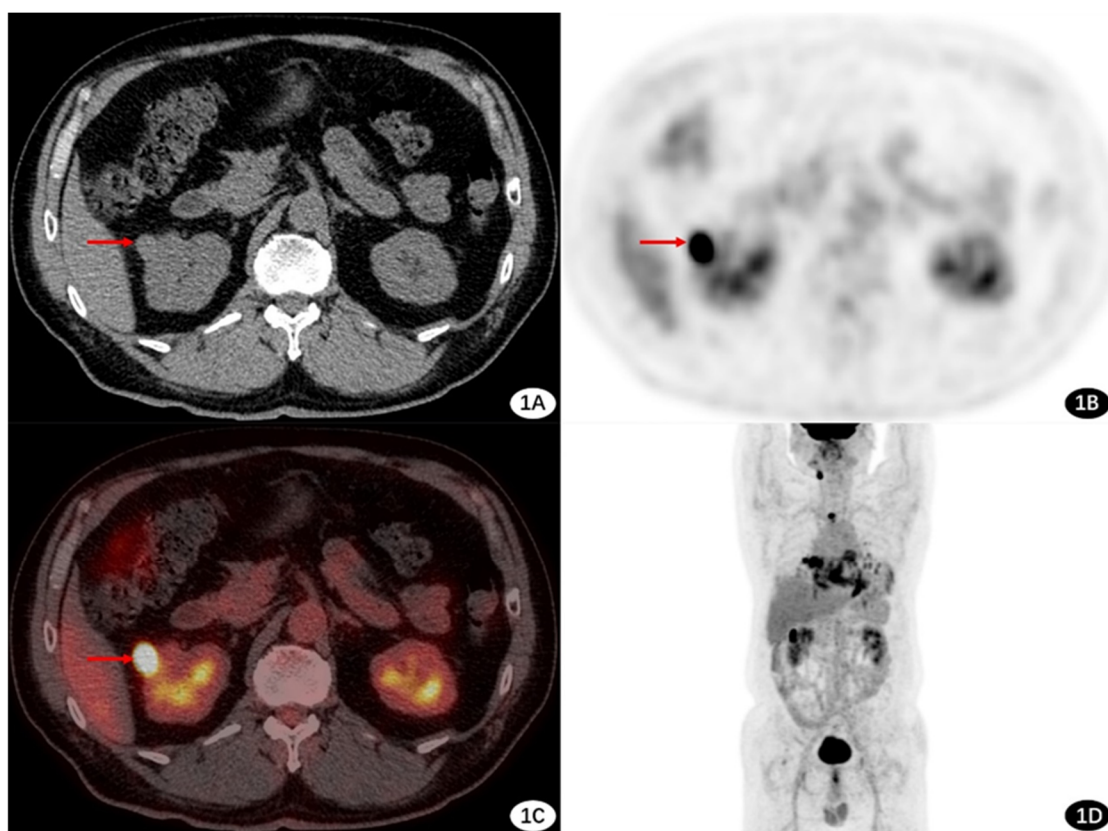


Figure 1. ^{18}F -FDG PET/CT examination results A: Axial CT image of the lesion; B: PET image of the lesion; C: PET/CT fusion image of the lesion; D: Maximum intensity projection (MIP) of the body

3. Results

During the surgery, the mass was observed on the ventral side of the upper pole of the right kidney under laparoscopy, with slight adhesions on the surface, abundant blood vessels, and a relatively clear boundary with the normal renal tissue. The size of the mass was approximately 2.5 $\times$ 1.6 $\times$ 1.7 cm, which was consistent with the size observed in imaging examinations.

Pathological macroscopic findings: The right kidney mass is gray-red tissue measuring approximately 2.0 $\times$ 1.8 $\times$ 1.5 cm. Its cut surface is gray-white or gray-red, has a solid texture and soft consistency, and is covered by a fatty capsule.

Pathological diagnosis: Microscopic examination shows tumor cells arranged in branching papillary patterns, with tumor tissue rich in mucin. The tumor cells have abundant,

eosinophilic cytoplasm, and the nuclei vary in size, with irregular shapes and a ground-glass appearance. Immunohistochemistry: #3: CK7 (+), CK19 (+), PAX-8 (+), TTF-1 (+), Galectin-3 (+), TG (focal +), RCC (-), BRAF (+), Ki-67 (approximately 5%, +), consistent with metastatic papillary thyroid carcinoma (**Figure 2**).

Final clinical diagnosis: Right kidney metastasis of papillary thyroid carcinoma. Diagnostic basis: An elderly male underwent PET/CT examination at our hospital, which revealed a right kidney upper pole isodense nodule, measuring approximately 2.4 $\times$ 1.5 $\times$ 1.8 cm, with increased FDG uptake, SUVmax 19.4. Considering the medical history and the characteristics of the lesions on PET/CT, renal metastatic tumor was suspected, and surgical treatment was performed. Postoperative pathology confirmed right kidney metastasis of papillary thyroid carcinoma. Differential

diagnosis: (1) Clear cell carcinoma of the kidney: Often accompanied by hemorrhage, necrosis, and cystic changes, presenting as heterogeneous lesions with typically low glucose metabolism. In this case, the isodense nodule shows significantly increased glucose metabolism, which is inconsistent with this diagnosis. (2) Eosinophilic cell adenoma of the kidney: Presents as round or slightly low-density masses, often with star-shaped scars, and FDG

PET/CT examination usually shows no significant difference in glucose metabolism compared to normal renal tissue. The characteristics in this case are inconsistent with this diagnosis. (3) Renal lymphoma: Presents as isodense or low-density masses, often with a specific "vascular floating sign" within the tumor, and PET/CT examination usually shows higher glucose metabolism. The characteristics in this case are inconsistent with this diagnosis.

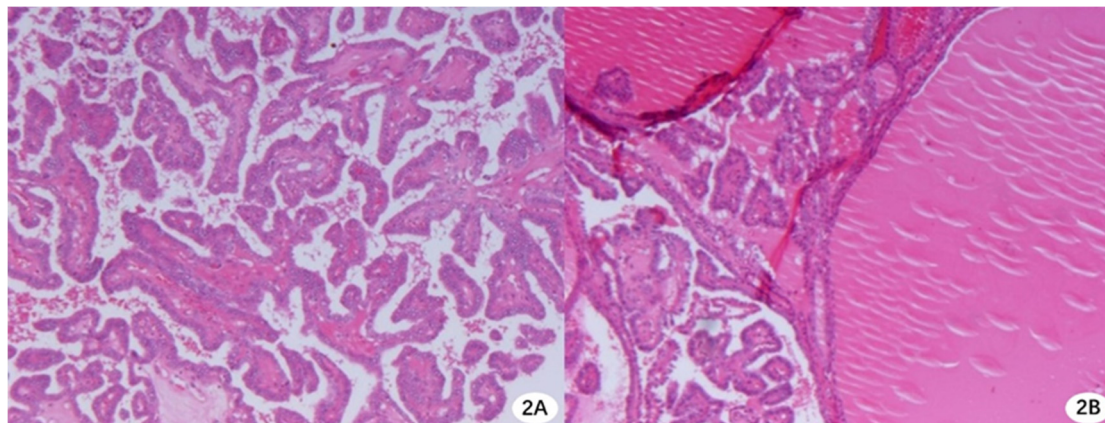


Figure 2. HE staining pathological image

4. Discussion

In recent years, the incidence of thyroid cancer has been increasing annually in countries around the world[8], primarily consisting of papillary thyroid carcinoma. Papillary thyroid carcinoma has a good prognosis, but metastasis is relatively common. When metastasis occurs, it usually first spreads to the lungs via local lymph nodes and then to the bones, with systemic multiple metastases occurring in rare cases [9]. Renal metastasis from papillary thyroid carcinoma is very rare [10], and diagnosis requires a combination of pathological immunohistochemical results. Immunohistochemical examination of metastatic papillary carcinoma from the thyroid shows positive thyroid globulin (Tg) and thyroid transcription factor-1 (TTF-1)[11], while Tg and TTF-1 are both negative in papillary carcinoma from non-thyroid sources. In this case, the right renal lesion showed cells with a follicular thyroid-like morphology under microscopy, and both Tg and TTF-1 were positive in the immunohistochemical examination. Combined with the patient's medical history, the diagnosis was made as right renal metastasis of papillary thyroid carcinoma.

Since renal metastasis from papillary thyroid carcinoma is very rare, such patients may be misdiagnosed as having a primary renal tumor when a renal mass is first discovered. In this case, the CT scan revealed a round isodense shadow at the upper pole of the right kidney, with mild to moderate ring enhancement on contrast imaging. These imaging features seem to suggest that the mass is a malignant tumor. However, the CT scan lacks the ability to assess the tumor's glucose metabolism, so the patient underwent an ^{18}F -FDG PET/CT scan following the CT examination. The ^{18}F -FDG PET/CT scan showed that the right upper pole lesion appeared as a round isodense nodule with increased glucose metabolism, which could easily be misdiagnosed as renal clear cell carcinoma, renal eosinophilic adenoma, or renal lymphoma, necessitating differentiation. Renal clear cell carcinoma often occurs in one kidney, and CT scans typically show isodense or low-density masses. Smaller tumors appear round or oval, while larger ones are round or irregular, often causing kidney

enlargement or local bulging. Cystic changes, hemorrhage, and necrosis often occur within the cancerous lesions, and enhancement typically shows a "fast in, fast out" pattern; low-grade renal clear cell carcinoma usually does not exhibit high glucose metabolism on FDG PET/CT scans[12]. Renal eosinophilic adenoma typically appears as a well-defined low-density round or oval mass on CT, with larger tumors occasionally showing central necrosis or hemorrhage; enhancement during cortical and medullary phases shows enhancement but is slightly lower than surrounding normal renal tissue; a central star-shaped scar is considered one of its imaging characteristics; FDG PET/CT examination usually shows no significant difference in glucose metabolism compared to normal renal tissue[13]. Renal lymphoma is less common, often presenting as multiple nodules or masses in both kidneys, appearing isodense, low-density, or slightly high-density on CT, with relatively uniform density, and relatively normal blood vessels can be seen within the tumor, forming a specific "vascular floating sign." CT enhancement often shows mild to moderate progressive delayed enhancement; FDG PET/CT examination of the tumor usually shows high glucose metabolism[14].

In this case, the upper pole mass of the right kidney measures approximately $2.4 \times 1.5 \times 1.8$ cm. The CT plain scan shows the mass to be isodense, with a regular round shape, protruding beyond the renal contour, and there is a clear boundary with the normal renal tissue. The contrast-enhanced scan shows mild to moderate ring enhancement; no cystic changes, calcification, or necrosis were observed within the nodule, nor were any relatively specific imaging signs such as "vascular floating sign," "fast in fast out," or "central star-shaped scar" noted. At the same time, PET/CT shows a significant increase in glucose metabolism of the mass, with an SUV max of 19.4. These characteristics are inconsistent with the features of the aforementioned tumor, aiding in differential diagnosis.

^{18}F -FDG PET/CT has certain advantages in the diagnosis of primary and secondary tumors of the kidney. This is mainly due to the ability of PET/CT to observe systemic lesions simultaneously, allowing for a comprehensive analysis and

assessment of the lesions and their affected areas, which helps to obtain more comprehensive disease information. Additionally, PET/CT can observe the lesions' characteristics on CT images and understand their function and metabolic status through the uptake of ^{18}F -FDG, combining morphological and functional metabolic information for comprehensive analysis, which aids in achieving a more accurate diagnosis. Given these advantages, PET/CT examinations often yield more comprehensive diagnostic results and more accurate disease staging, facilitating the formulation of treatment plans and ultimately helping patients achieve better prognosis. However, ^{18}F -FDG PET/CT also has certain limitations, as ^{18}F -FDG primarily participates in the uptake of glucose by tissue cells, mainly reflecting the level of glucose uptake in organs, tissues, and cells, thus having poor specificity, which can manifest as high uptake in various lesions. Therefore, combining other information for comprehensive analysis is necessary to obtain an accurate diagnosis during diagnosis.

Finally, this case report hoped to increase the diagnostic rate of the rare disease of renal metastasis from papillary thyroid carcinoma among peers, promoting better diagnosis and treatment for such patients.

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