Incidental Bilateral Renal Oncocytoma in a Patient with Metastatic Carcinoma of Unknown Primary: a Pitfall on ^{18}F -FDG PET/CT

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Abstract Bilateral renal masses are uncommon but can raise a strong suspicion of primary or secondary malignancy, especially during the initial work-up of an oncology patient. Renal oncocytomas are benign renal tumors that are commonly discovered incidentally on diagnostic imaging with a small percentage occurring bilaterally. Although ^{18}F -FDG uptake in renal oncocytomas has been described, a case of a bilateral ^{18}F -FDG-avid renal oncocytoma has not been previously reported in the literature. A variety of malignant causes of bilateral ^{18}F -FDG positive renal masses are known, however it is important to include this benign etiology in the differential diagnosis. We report an unusual case of an incidental bilateral renal oncocytoma evaluated with contrast enhanced CT and ^{18}F -FDG PET/CT.

Keywords Bilateral renal oncocytoma · Bilateral renal mass · FDG · PET/CT

Introduction

Bilateral renal masses are uncommon but can raise a strong suspicion of primary or secondary malignancy,

especially during the initial work-up of an oncology patient. Renal oncocytomas are benign renal tumors that are commonly discovered incidentally on diagnostic imaging with a small percentage occurring bilaterally. Although ^{18}F -FDG uptake in renal oncocytomas has been described, a case of a bilateral ^{18}F -FDG-avid renal oncocytoma has not been previously reported in the literature. A variety of malignant causes of bilateral ^{18}F -FDG positive renal masses are known, however it is important to include this benign etiology in the differential diagnosis. We report an unusual case of an incidental bilateral renal oncocytoma evaluated with contrast-enhanced CT and ^{18}F -FDG PET/CT.

Case Report

A 64-year-old man presented with a several-month history of an enlarging left paraspinal neck mass. A contrast-enhanced CT, as well as a gadolinium-enhanced MRI of the neck (Fig. 1), showed a 7.5 cm mass deep to the left trapezius, involving the left spinalis cervicis, semispinalis cervicis and capitis, and longissimus cervicis muscles. Biopsy of this neck mass revealed a metastatic poorly differentiated carcinoma, positive for CK7 and negative for CK20, suggestive of a pulmonary origin. The remainder of the immunohistochemistry showed AE1/3 (+), 34BE12 (+), S100 (–), TTF-1 (–), MART-1 (–), MELAN-A (–), Vimentin (–), PSA (–), PSAP (–).

The patient was referred for an ^{18}F -FDG PET/CT (Discovery ST, GE Healthcare, Canada) to help identify and locate the primary tumor. The patient was fasted overnight prior to the examination and waited in a quiet, dark room the morning of the scan. An ^{18}F -FDG emission scan extending from the base of the skull to the mid-thigh was obtained 60 min after intravenous injection of

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Fig. 1 **a** Transaxial view of a contrast-enhanced CT shows an enhancing mass in the left paraspinal muscles. **b** Transaxial view of a gadolinium-enhanced MRI also shows enhancement in the left paraspinal mass

15.2 mCi (562.4 MBq) of ^{18}F -FDG. The emission scan was acquired for 5 min per field of view, each covering 15 cm, at an axial sampling thickness of 3.75 mm/slice. The 16-slice helical CT acquisition was performed prior to a full-ring dedicated PET scan of the same axial range. The CT component was operated with an X-ray tube voltage peak of 140 kVp, 80 mA, a 1.75:1 pitch, a slice thickness of 3.75 mm, and a rotational speed of 0.8 s/rotation. The patient was allowed to breathe normally during the PET and CT acquisitions. PET images were reconstructed with CT-derived attenuation correction using ordered subset expectation maximization software. Only the maximum standardized uptake value (SUV_{max}) was reported, corrected for body weight.

Maximum intensity projection (MIP) images (Fig. 2) show a very intensely FDG-avid neck mass with SUV_{max} of 18.2. This mass involved multiple left paraspinal muscles and extended to the first and second intercostal spaces. Multiple small FDG-avid lymph nodes were seen in the left jugulodigastric region with SUV_{max} of 5.4. The largest lymph node measured 1.3 cm and was located posterior to the internal jugular vein, at the level of the

thyroid. Incidentally, two FDG-avid renal masses were identified, one in each kidney (Figs. 3, 4). The right renal mass was located in the inferior pole, measuring 7.5 cm in transverse diameter, and was associated with heterogeneous FDG uptake with SUV_{max} of 6.0. The left renal mass was also located in the inferior pole, measuring 2.4 cm in transverse diameter, and had a more homogeneous appearance with SUV_{max} of 5.5. There were no other suspicious FDG-avid masses in the remainder of the study. The possibilities of either a primary bilateral renal malignancy or bilateral renal metastases were raised, especially in the context of a patient with a neck metastasis of an unknown primary carcinoma.

A contrast-enhanced CT of the abdomen was performed (Fig. 5). The right renal mass was described as measuring $9 \times 7.4 \times 7.3$ cm, showing heterogeneous enhancement with necrotic areas, associated with peritumor fat stranding and a thickened Gerota's fascia, suspicious for a renal cell carcinoma. The left renal mass measured $2.7 \times 2.2 \times 2.0$ cm with minimal perinephric fat stranding. The patient had a right nephrectomy due to the size and suspicious nature of the renal mass. Histopatho-

Fig. 2 ^{18}F -FDG PET/CT (Discovery ST, GE Healthcare, Canada) maximum intensity projection (MIP) images with **a** anterior and **b** posterior views show an $8.0 \times 5.0 \times 5.0$ cm neck mass with SUV_{max} of 18.2. There were multiple small FDG-avid left neck lymph nodes with SUV_{max} of 5.4. Incidental findings included a 7.5 cm mass in the lower pole of the right kidney with SUV_{max} 6.0 (*left arrow*) and a 2.4 cm mass in the lower pole of the left kidney with SUV_{max} 5.5 (*right arrow*)

Fig. 3 **a** Coronal view of a contrast-enhanced CT shows the bilateral renal oncocytomas. **b** Corresponding PET, **c** CT portion of the PET/CT, and **d** PET/CT fusion images

logic evaluation showed a yellow brown tumor, internally hemorrhagic with fibrous streaks. The mass pushed against the renal capsule but did not penetrate it. The findings were consistent with a 7.5 cm renal oncocytoma. Shortly thereafter, the patient had a biopsy of the left renal mass, which also showed an oncocytoma.

The patient received radiation therapy for the neck mass and had a follow-up PET/CT 3 months following the completion of radiotherapy (Fig. 6). The neck mass was slightly reduced in size, showing a mildly decreased SUV_{max} of 15.0, and the previously seen left neck lymph nodes were no longer present. The left renal oncocytoma was once again visualized, with no significant change in

either size or FDG uptake (with SUV_{max} of 6.1). There was also a new FDG-avid bone metastasis in a transverse process of the T1 vertebra.

Discussion

Renal oncocytomas account for 5% of all solid renal neoplasms, and approximately 60% are diagnosed incidentally. Symptomatic patients usually present with gross hematuria, flank pain, or a palpable mass. Average tumor size is 6 cm, peak occurrence is between ages 40 and 60, and the male-to-female ratio is 2–3:1 [1]. Approximately

Fig. 4 **a** Transaxial view of a contrast-enhanced CT shows the bilateral renal oncocytomas. **b** Corresponding PET, **c** CT portion of the PET/CT, and **d** PET/CT fusion images

Fig. 5 Coronal views (**a**, **b**, **c** progressively posterior) of a contrast-enhanced CT show masses in the lower poles of both kidneys. The right renal mass was described as measuring $9 \times 7.4 \times 7.3$ cm, showing heterogeneous enhancement with necrotic areas, associated

with peri-tumor fat stranding and a thickened Gerota's fascia, suspicious for a renal cell carcinoma. The left renal mass measured $2.7 \times 2.2 \times 2.0$ cm with minimal perinephric fat stranding

5% of renal oncocytomas are bilateral, and 10% of renal oncocytomas occur in coincidence with a renal cell carcinoma [2, 3]. There is paucity of literature regarding the imaging characteristics of renal oncocytomas on ^{18}F -FDG PET/CT, however reports of two cases suggest they can be intensely FDG-positive [4, 5].

Oncocytomas are benign tumors composed of oncocytes—large polyhedral cells with voluminous finely granular eosinophilic cytoplasm seen on hematoxylin and eosin stains. Electron microscopy has shown that oncocytic cells contain a large amount of mitochondria, which at times have been noted to be either normal or abnormal in character [6]. It is the accumulation of metabolically active mitochondria that is the likely cause of intense ^{18}F -FDG uptake, which has been reported in

various types of non-renal oncocytomas as well, including the salivary glands (parotid, submandibular, and minor salivary glands) [6–8], adrenal gland [9], retroperitoneum [10], and pancreas [11, 12].

Many different processes can cause focal ^{18}F -FDG uptake in the kidney, which makes the assessment of renal malignancy by PET/CT difficult. This includes infectious or inflammatory processes such as renal cyst infections in polycystic kidney disease [13], xanthogranulomatous pyelonephritis [14], benign tumors such as renal angiomyolipoma [15], and malignant tumors including renal cell carcinoma (RCC) [16], renal lymphoma [17], Wilms tumor [18], and renal metastases [19]. The role of ^{18}F -FDG PET/CT in the detection of RCC is limited, as several studies have reported high false negative rates [5, 20]. The ^{18}F -

Fig. 6 A follow-up PET/CT performed 3 months following the end of radiotherapy to the neck. MIP images with **a** anterior and **b** posterior views show the left neck mass decreased slightly in size with SUV_{max} of 15.0. The previously seen left neck lymph nodes have resolved. The left renal oncocytoma persists, with no significant change in size or FDG uptake with SUV_{max} of 6.1. There was also a new FDG-avid bone metastasis in a transverse process of T1 vertebra

FDG uptake in RCC varies based on the histological subtype, with one study suggesting a sensitivity of 100% for papillary RCC, compared to a sensitivity of 75% for clear cell RCC [21]. Hence, PET/CT may only have a complementary role in primary RCC as a problem-solving tool in cases that are equivocal on conventional imaging. Meanwhile, the role of ^{18}F -FDG PET/CT for follow-up or suspected recurrence of RCC has been reported to be favorable [22, 23].

Bilateral renal masses are uncommon. The proportion of RCCs that are bilateral is about 2–4%, although this can rise up to 40% in patients with tuberous sclerosis [24]. Renal oncocytomas are bilateral in 5% of cases. There is also a condition known as renal oncocytosis that presents with diffuse involvement of the kidneys by numerous oncocytomas [25]. To our knowledge, there has been no previous case of bilateral ^{18}F -FDG-positive renal oncocytomas described in the literature. ^{18}F -FDG PET/CT cannot definitively differentiate a benign case of a bilateral renal oncocytoma from the various malignant causes of bilateral FDG-avid masses reported in the literature such as renal cell carcinoma [26], lymphoma [17, 27], Wilms tumor [28, 29], and metastases [30]. However, it is important to be aware of this benign differential diagnosis, as the possibility of a benign etiology may affect the patient's diagnostic work-up and subsequent management. Although our patient had a right nephrectomy due to the large size of the renal mass, its suspicious appearance on contrast-enhanced CT and ^{18}F -FDG PET/CT, and in the context of a search for a primary malignancy to explain a metastatic carcinoma in the neck, such radical management would not be necessary in most patients. In a case where incidental bilateral FDG-avid renal masses are discovered on a PET/CT, and a biopsy of one of the masses reveals an oncocytoma, the possibility of bilateral renal oncocytomas should be considered, and the lesions can be followed conservatively with a follow-up contrast-enhanced CT or PET/CT to assess for lesion stability in terms of both size and FDG uptake.

In conclusion, bilateral renal masses discovered incidentally on an ^{18}F -FDG PET/CT that are strongly FDG-avid should not be assumed to be malignant in nature, as they could represent a benign case of bilateral renal oncocytoma, which can be confirmed by biopsy, managed conservatively, and monitored on follow-up PET/CT scans.

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