

# Oncocytoma: A Differential Consideration for an Incidentally Detected FDG-Avid Renal Mass on PET/CT


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## ABSTRACT

Renal oncocytoma is a benign renal neoplasm that is often discovered incidentally and closely mimics renal cell carcinoma on common imaging modalities such as computed tomography (CT) and magnetic resonance imaging (MRI). Due to the inability to reliably distinguish between these benign and malignant lesions with imaging, both are typically treated as if they are malignant. Hypermetabolic activity of renal oncocytomas is not frequently encountered because positron emission tomography (PET) is not a standard modality for imaging primary renal tumors. We present a case of a 65 year-old female with a history of thyroid cancer who had an incidentally discovered hypermetabolic renal mass on surveillance PET-CT imaging. Due to the concern for a primary renal malignancy or metastatic disease, the mass was resected and proven to be an oncocytoma on pathologic review.

## CASE REPORT

### CASE REPORT

A 65 year-old African-American female with a past medical history of papillary thyroid cancer status post total thyroidectomy and oral radioactive iodine therapy 8 months prior presented after a 7 cm mass was found incidentally in the upper pole on the left kidney on a surveillance F<sup>18</sup>-FDG positron emission tomography - computed tomography (PET/CT) scan. The mass demonstrated increased FDG uptake with a standard uptake value (SUV) maximum of 4.4 (Figure 1).

A multiphase CT with intravenous contrast demonstrated a 7.0 x 6.5 x 6.7 cm exophytic mass arising from the anterior cortex of the upper pole of the left kidney. This solid mass

showed heterogeneous arterial enhancement with washout on nephrographic and excretory phase imaging (Figure 2). There was no lymphadenopathy, direct extension into nearby organs, or renal vein involvement. The case was presented at multidisciplinary tumor board. The consensus was that the hypermetabolic renal mass was likely a primary renal neoplasm rather than metastatic thyroid cancer. A decision was made to proceed with surgical management of the lesion.

Laparoscopic left radical nephrectomy was performed via a midline infraumbilical incision. Once isolated, the left renal tumor was entrapped within a 15 mm laparoscopic entrapment sack and extracted through the midline incision. The left renal mass was completely resected without complication. The

patient recovered well without significant postoperative morbidity.

Histologically, the tumor showed occasional tubules and nests of cells with abundant eosinophilic, granular cytoplasm and prominent central nucleoli embedded in a hypocellular hyalinized stroma (Figure 3), all consistent with an oncocytoma rather than a malignant renal cell carcinoma.

## DISCUSSION

### *Etiology & Demographics:*

Renal oncocytomas represent a subset of tumors called “oncocytic renal neoplasms.” Oncocytoma is a relatively uncommon benign oncocytic neoplasm of epithelial origin, accounting for approximately 5% of all solid renal tumors [1]. They are discovered incidentally in 60% of patients [1]. Renal oncocytomas have a 2-3:1 male to female predilection and most commonly present in the sixth to seventh decades of life [2].

### *Clinical & Imaging Findings:*

Although patients are usually asymptomatic, hematuria, flank pain, and a palpable mass are the most common clinical manifestations of patients presenting with symptoms from an oncocytoma [1]. Cases have been reported measuring up to 27 cm in greatest dimension [3]. As in our case, renal oncocytomas are usually diagnosed after biopsy or resection, as these benign lesions cannot be reliably distinguished from renal cell carcinomas (RCC) on imaging alone [4]. Previous studies have elucidated specific characteristics that may help differentiate oncocytoma from renal cell carcinoma on CT. Bird et al. showed that oncocytoma had the highest mean enhancement change in arterial, venous and delayed phase images and differed significantly when comparing with renal cell carcinoma [5]. Pano et al. reported that parameters such as lesion size larger than 4 cm, lesion enhancement in the excretory phase in relation to the unenhanced phase, and a heterogeneous enhancement pattern can help differentiate oncocytoma from renal cell carcinoma [6]. Choi et al. concluded that a central stellate scar and higher mean Hounsfield unit values in the nephrogenic phase were highly predictive of renal oncocytoma [7]. Similarly, Wu et al. reported that a stellate scar, spoke-wheel-like enhancement, and segmental enhancement inversion were common features of renal oncocytoma, which can help differentiate it from chromophobe renal cell carcinoma [8]. Recently, Dhyani et al. reported that an Aorta-Lesion-Attenuation-Difference of less than 25 in addition to the presence of a central scar and lack of calcifications were significant indicators of oncocytoma compared to chromophobe renal cell carcinoma [9]. Despite these promising studies, histopathology remains the gold standard for distinguishing oncocytoma from renal cell carcinoma because certain imaging characteristics are difficult to reproduce. For example, some case series show that only a minority of oncocytomas demonstrate the classic central

stellate scar, such as the study by Choudhary et al. in which 78.6% of oncocytomas in their cohort did not show a scar on CT or pathologically [10].

The use of PET/CT is not routinely performed in the workup of benign and malignant renal masses. The PET/CT was performed in this case as surveillance imaging for the patient’s papillary thyroid cancer. Renal cell carcinomas typically demonstrate variable levels of FDG uptake ranging from similar to background renal parenchyma to marked uptake [11]. In general, benign neoplasms do not demonstrate increased FDG uptake. However, a few FDG-avid renal oncocytomas have been reported in the literature [1, 12].

The diagnosis is typically confirmed by histologic review of the tissue [14]. The hallmark of oncocytic cells is abundant eosinophilic cytoplasm [2]. While there are no biomarkers used to diagnose renal oncocytoma pre-operatively, there are useful biomarkers such as CK7 that can be used to distinguish renal oncocytoma and chromophobe renal cell carcinoma on resection specimens. Use of other markers such as HNF1 $\beta$  and S100A1 have also been reported, although these are not used in routine pathology clinical practice [14].

### *Differential Diagnoses:*

Oncocytomas closely resemble primary renal malignancies on imaging, particularly other oncocytic renal neoplasms such as chromophobe renal cell carcinoma and type 2 papillary renal cell carcinoma. They can be difficult to distinguish even with active surveillance, as renal oncocytomas have been shown to demonstrate preoperative growth rates similar to renal cell carcinoma [15]. Metastasis to the kidney is another differential consideration. Less common entities such as renal leiomyoma and metanephric adenoma can usually be differentiated from oncocytoma by T2 hypointensity on MR and heterogeneity and necrosis on CT or MR, respectively.

#### *Chromophobe Renal Cell Carcinoma*

Chromophobe renal cell carcinoma (chRCC) is a low-grade renal malignancy that can exhibit aggressive clinical behavior. It has a more favorable prognosis than clear cell or papillary renal cell carcinoma. It represents 3-10% of all renal cell carcinoma with an equal predilection for men and women [2]. Despite its similarity to oncocytoma on CT, chRCC is less likely to demonstrate a central scar, segmental enhancement inversion, and lesion heterogeneity [6-9].

#### *Papillary Renal Cell Carcinoma*

Papillary RCC is the second most common renal cell carcinoma behind clear cell RCC. It accounts for 15% of renal cancers [2]. There are two types of papillary RCC, type 1 and type 2. Histologically, type 2 papillary RCC is classified as an oncocytic renal neoplasm, which can resemble oncocytoma on CT. T2 hypointensity on MRI is a helpful signal characteristic to suggest a diagnosis of papillary RCC [16].

#### *Renal Metastasis*

Hematologic metastasis to the kidney may mimic the appearance of primary renal neoplasms, such as oncocytoma.

A history of a separate primary malignancy is a clue in distinguishing these entities. However, biopsy or surgical resection may still be necessary in some cases to help guide management.

#### Treatment & Prognosis:

Because renal oncocytoma closely mimics renal cell carcinoma on imaging, treatment options mirror those for primary renal malignancy. These include resection via partial or total nephrectomy, percutaneous cryoablation, and active surveillance. A patient's overall health and performance status usually dictates management. Patients with pathologically proven renal oncocytoma have excellent prognosis because this benign neoplasm harbors no malignant potential.

#### TEACHING POINT

While benign renal neoplasms typically do not demonstrate increased FDG uptake on PET/CT imaging, oncocytomas can demonstrate hypermetabolism. Although extremely uncommon, oncocytoma is a differential diagnosis for an incidentally detected hypermetabolic renal mass.

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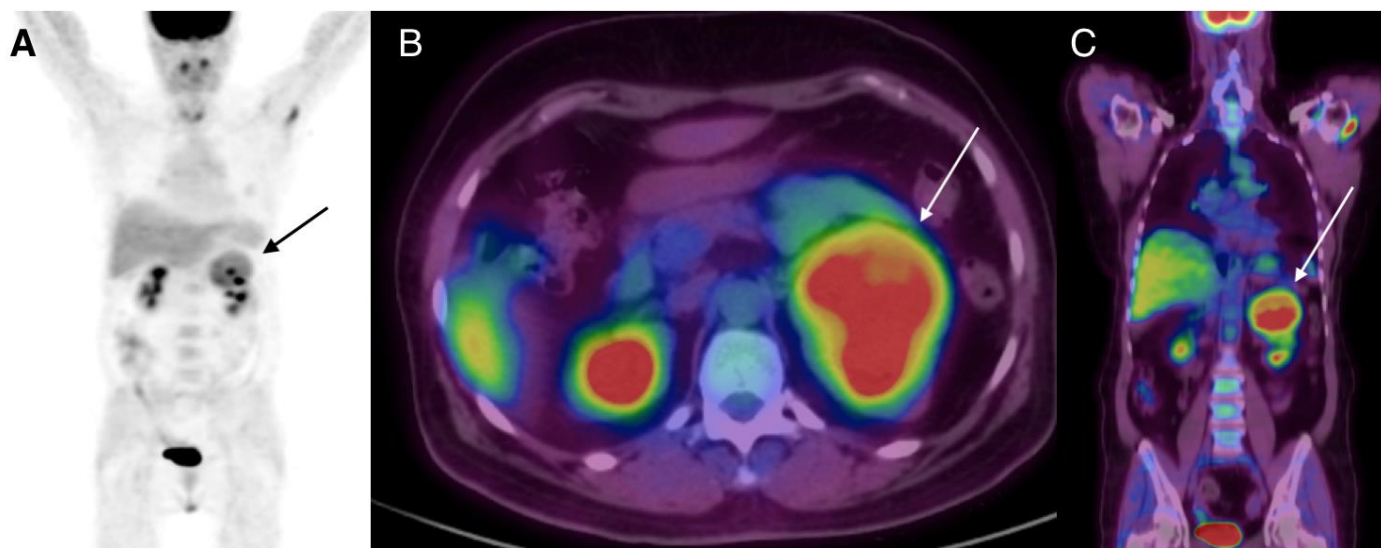
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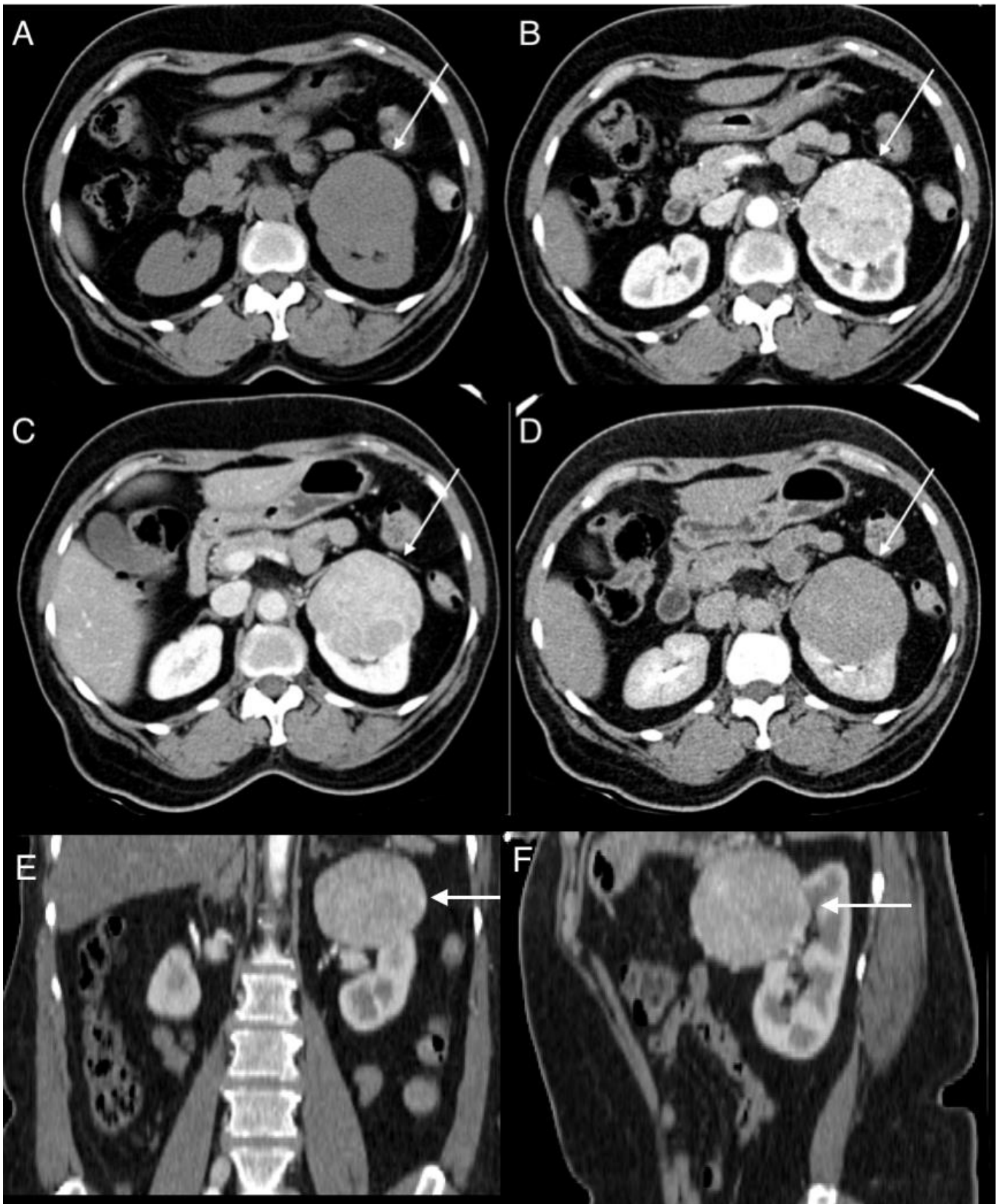
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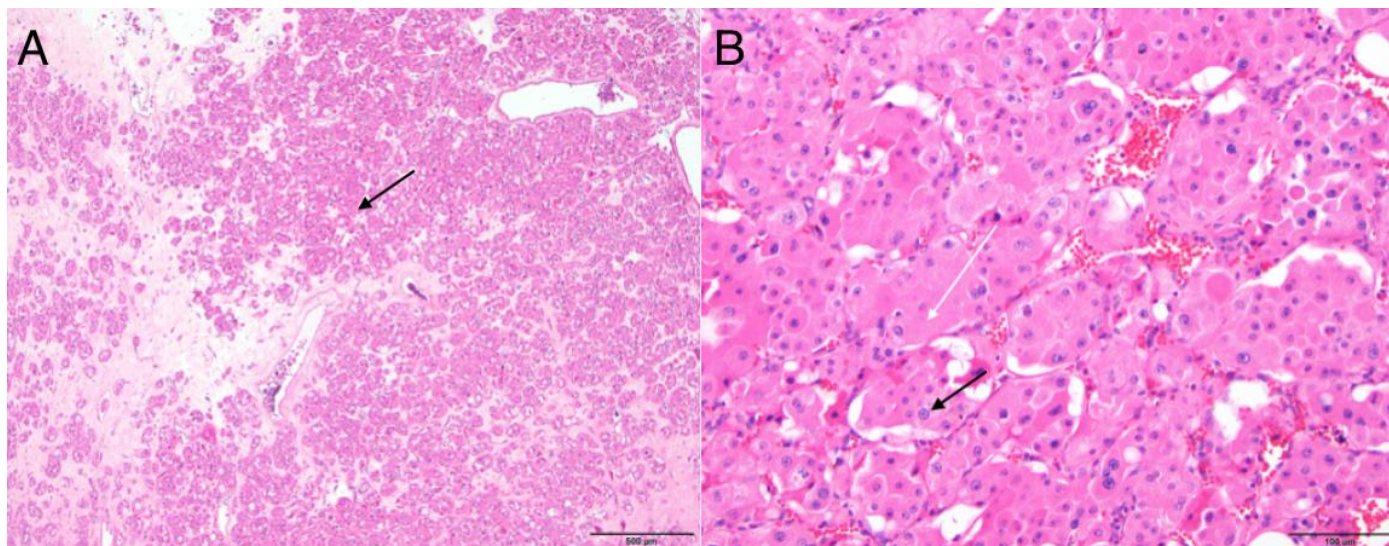
FIGURES



**Figure 1:** 65 year-old female with a left-sided renal oncocytoma. Coronal maximum intensity projection images from a PET exam utilizing 13 mCi F18-FDG after 12 hours of fasting with images obtained 90 minutes after injection (A) demonstrate a well-circumscribed mass in the upper pole of the left kidney with increased FDG uptake (arrow). The 7 cm tumor extends from the superior left kidney with mass effect on surrounding structures. Fused axial (B) and coronal (C) PET/CT images (unenhanced with 5 mm thick slices) demonstrate increased FDG uptake in the mass with an SUV Max of 4.4 (arrows). There are no local or distant hypermetabolic metastatic lesions.



**Figure 2:** 65 year-old female with a left-sided renal oncocytoma. Axial CT images (Siemens Sensation 16, 165-170 mAs, 120 kVp, 5 mm slice thickness) in the non-contrast (A), arterial (B), venous (C), and 7 minute delayed (D) phases before and after 100 mL Omnipaque 350 intravenous contrast demonstrate a well-circumscribed exophytic 7.0 x 6.5 x 6.7 cm mass emanating from the anterior superior pole of the left kidney with heterogeneous arterial enhancement and progressive washout on later phases (arrows). There is mild displacement of adjacent structures but no direct invasion into nearby organs. Coronal (E) and sagittal (F) reformatted images in the arterial phase showing the exophytic left renal mass (arrows) with a clear fat plane between the left adrenal gland and bowel.



**Figure 3:** 65 year-old female with a left-sided renal oncocytoma. Hematoxylin and eosin stain. A. Tumor demonstrating nests and occasional tubules (arrow) embedded in a hypocellular hyalinized stroma (40x magnification). B. Nested architecture of cells with abundant eosinophilic granular cytoplasm (white arrow) and prominent central nucleoli (black arrow) (200x magnification).

<b>Etiology</b>	Renal oncocytomas arise from epithelial cells [2]
<b>Incidence</b>	Oncocytomas represent approximately 5% of all solid renal tumors [1]
<b>Gender Ratio</b>	There is a 2-3:1 male-to-female ratio [2]
<b>Age Predilection</b>	Oncocytomas usually present between 50-60 years of age [2]
<b>Risk Factors</b>	There are no known risk factors, however, co-existing renal cell carcinoma may occur
<b>Treatment</b>	Oncocytomas are typically surgically resected as these are difficult to distinguish from renal cell carcinoma preoperatively. However, patients with biopsy proven oncocytoma can be conservatively managed through active surveillance [17].
<b>Prognosis</b>	The prognosis is excellent as oncocytomas are benign neoplasms with no metastatic potential
<b>Findings on Imaging</b>	CT and MRI typically show an avidly enhancing renal mass and may show central scar. In rare instances, oncocytoma can be hypermetabolic on PET imaging.

**Table 1:** Summary table of Renal Oncocytoma.

Differential Diagnosis	CT Findings	MRI Findings	PET Findings
<b>Renal Oncocytoma</b>	<ul style="list-style-type: none"> <li>• Homogenous or heterogeneous attenuation with avid early enhancement</li> <li>• Central stellate non-enhancing scar</li> </ul>	<ul style="list-style-type: none"> <li>• T1: hypointense compared to renal cortex</li> <li>• T2: hyperintense compared to renal cortex, may demonstrate hypointense central stellate scar</li> </ul>	<ul style="list-style-type: none"> <li>• May have uptake of FDG [18]</li> </ul>
<b>Renal Cell Carcinoma</b>	<ul style="list-style-type: none"> <li>• Variable enhancement during corticomedullary and nephrographic phases</li> <li>• +/- necrosis</li> <li>• +/- Extension into venous circulation</li> </ul>	<ul style="list-style-type: none"> <li>• T1: heterogeneous due to necrosis, hemorrhage and solid components</li> <li>• T2: hyperintense (clear cell), hypointense (papillary) [16]</li> </ul>	<ul style="list-style-type: none"> <li>• May be PET-positive [18]</li> </ul>
<b>Renal Leiomyoma</b>	<ul style="list-style-type: none"> <li>• Well-circumscribed margins</li> <li>• Capsular/subcapsular or peripelvic origin</li> <li>• Minimal parenchymal distortion</li> <li>• No extra-renal invasion</li> </ul>	<ul style="list-style-type: none"> <li>• T1: heterogeneous with internal areas of hypointensity</li> <li>• T2: uniform hypointense signal</li> <li>• Avid homogenous contrast enhancement.</li> </ul>	<ul style="list-style-type: none"> <li>• No significant FDG avidity</li> </ul>
<b>Metanephric Adenoma</b>	<ul style="list-style-type: none"> <li>• Hyperattenuating mass</li> <li>• Heterogeneous, hypovascular with foci of hemorrhage and necrosis</li> <li>• Calcification</li> </ul>	<ul style="list-style-type: none"> <li>• T1: hypointense signal</li> <li>• T2: slightly hyperintense</li> </ul>	<ul style="list-style-type: none"> <li>• PET not applied</li> </ul>
<b>Renal Metastasis</b>	<ul style="list-style-type: none"> <li>• Solid organ metastases</li> <li>• Hematogenous spread</li> <li>• Small, multicentric and bilateral</li> </ul>	<ul style="list-style-type: none"> <li>• T2: hyperintense</li> <li>• +/- multifocal</li> <li>• Hematogenous spread</li> </ul>	<ul style="list-style-type: none"> <li>• Intense FDG uptake from common sources of renal metastasis (lymphoma, lung cancer, non-mucinous colon cancer) [18]</li> </ul>

**Table 2:** Differential diagnosis table for Renal Oncocytoma.

**ABBREVIATIONS**

CT - computed tomography  
 F18-FDG - fluorodeoxyglucose  
 MRI - magnetic resonance imaging  
 PET - positron emission tomography

**KEYWORDS**

Oncocytoma; PET/CT; Renal cell carcinoma; FDG-avid; Renal mass

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