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Computed Tomography Appearance of Renal Hybrid Oncocytic/Chromophobe Tumors

Akrita Bhatnagar, PhD^{*}, Steven P. Rowe, MD, PhD^{*}, Michael A. Gorin, MD[†], Martin G. Pomper, MD, PhD^{*}, Elliot K. Fishman, MD^{*}, and Mohamad E. Allaf, MD[†]

^{*}Russell H. Morgan Department of Radiology and Radiological Science, Johns Hopkins University School of Medicine, Baltimore, MD

[†]The James Buchanan Brady Urological Institute and Department of Urology, Johns Hopkins University School of Medicine, Baltimore, MD

Abstract

Objective—A series of renal hybrid oncocytic/chromophobe tumors (HOCTs) was retrospectively assessed for morphologic features and enhancement characteristics by computed tomography (CT).

Materials (Subjects) and Methods—Nine patients with pathologically proven HOCTs were identified. These patients harbored a total of 12 lesions. All patients had available preoperative contrast-enhanced CT examinations, although a proportion of the studies had been carried out at outside institutions. The morphologic characteristics and enhancement patterns of each tumor were evaluated systematically.

Results—Seventy-eight percent of the patients were men, with a mean age of 62 years. None of the patients had evidence of metastatic disease at the time of surgery. Mean tumor diameter was 4.4 cm. All the lesions were solid and well circumscribed. Calcifications were not seen in any of these masses. Thirty-three percent of the tumors demonstrated a central stellate hypodensity pattern, whereas a further 42% of the tumors demonstrated a heterogenous appearance. Mean attenuation values were 25.7 HU (noncontrast), 77.4 HU (arterial), 124.8 HU (venous), and 76.8 HU (delayed). Tumor-to-cortex ratios for the 2 enhanced phases (arterial and venous) were 0.56 and 0.79, respectively.

Conclusions—A series of HOCTs were found on CT to have 2 distinct patterns—a heterogenous enhancement pattern and an “oncocytoma-like” pattern with a central stellate hypodensity. Although the prospective diagnosis of HOCTs on the basis of CT findings is unlikely, an awareness of the existence of these lesions is important as new means of characterizing renal masses on imaging arise.

Keywords

renal hybrid tumors; small renal masses; computed tomography

Correspondence to: Steven P. Rowe, MD, PhD, Russell H. Morgan Department of Radiology and Radiological Science, The Johns Hopkins Hospital, 600 N Wolfe, Baltimore, MD 21287 (srowe8@jhmi.edu).

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The recognition of the existence of hybrid oncocytic/chromophobe tumors (HOCTs) of the kidney has been fairly recent, with the first case report published in 1995 and the first case series reported in 2005.¹ Hybrid oncocytic/chromophobe tumors are composed of varying amounts of cells with features of renal oncocytomas (ROs) and chromophobe renal cell carcinomas (chRCCs). It has been reported that patients with oncocytomas on renal tumor biopsies should be informed that there is a 15% to 18% risk that the tumor might be a HOCT.² It is thought that HOCTs are an indolent subtype of renal tumor, and it has recently been argued that these tumors have a benign clinical course.^{1,2} It is particularly reassuring that, among patients with renal mass biopsy indicating oncocytoma, who regardless choose to proceed to surgical resection and are found on definitive pathology to have HOCTs, these patients have excellent long-term outcomes. In addition, the literature supports the claim of HOCTs to be nonaggressive, with no reports of local recurrence and only 1 case report of distant metastasis.¹

Hybrid oncocytic/chromophobe tumors arising sporadically seem to be cytogenetically distinct from chRCC and have some genetic similarities to RO.^{3,4} Most frequently, these tumors have been described in patients with (1) chronic renal failure/long-term hemodialysis or (2) Birt-Hogg-Dubé syndrome, or (3) in association with non-syndromic renal oncocytosis.⁵

The incidence of renal masses has increased dramatically in recent years,^{6,7} and despite their rarity, this increase presumably also includes HOCTs. Thus, the appropriate identification and management of these tumors is of increasing importance in the practices of radiology and urology. To our knowledge, only 2 studies have described the imaging features of a total of 4 patients with HOCTs in oncocytosis.^{8,9} Herein, we describe the computed tomography (CT) appearance of a series of 12 HOCTs as assessed by morphologic characteristics and enhancement patterns, using an overall approach that has previously been used in the description of uncommon renal masses.¹⁰

Materials and Methods

Study Population

Patient informed consent was waived in this retrospective study. An institutional review board-approved clinical registry containing information on all renal masses treated at our institution from 2003 through 2014 was queried for the presence of pathologically confirmed HOCTs. During this 11-year period only 11 patients were found to have HOCTs on surgical pathology. Two of the patients had all imaging performed at outside facilities, and no preoperative CTs were available for those patients in our institution's picture archiving and communication system. Those 2 patients were excluded from the analysis. The remainder of the patients had picture archiving and communication system-accessible preoperative CT of the abdomen and pelvis. The electronic medical records of these patients were reviewed for demographic information. None of these patients underwent lymph node dissection, hence no information regarding lymph node status was available. None of these patients were suspected at the time of surgery of having metastatic disease.

Imaging Review

Six of the patients included in this study had complete renal protocol CT evaluation that included noncontrast, arterial (corticomedullary), venous (nephrographic), and delayed phases, which is the standard renal mass imaging protocol at our institution. The remaining 3 patients had studies including noncontrast, venous, and delayed phase imaging—all of those patients were imaged at outside institutions but ultimately deemed clinically not to require a repeat study with arterial imaging. None of the patients in this study had more than 1 accessible CT—as such, no information on changes in tumor sizes over time was available.

The CT images were reviewed on a Mirada Workstation (Mirada Medical, Oxford, UK). A number of morphologic and enhancement features of the identified HOCTs were evaluated. For each tumor, shape (spherical vs irregular), presence or absence of central hypodensity/hypoenhancement (suggesting central scar or necrosis), presence or absence of calcifications, laterality (left or right), and location in the craniocaudal dimension (upper pole, interpolar, lower pole) were noted. Enhancement of the tumors relative to major vascular structures was assessed. In addition, tumors were evaluated using the R.E.N.A.L. Nephrometry scoring system.¹¹

Results

Patient Demographics and Characteristics at Presentation

Table 1 includes demographic information on the 8 patients included in this study. The mean age was 62 years (range, 52–74 years). Seven of the patients were men, and 2 were women. Seven of the 9 patients had solitary masses, with 1 patient having 2 identifiable tumors and a final patient having 3.

Imaging Results

Table 2 summarizes the morphologic features for each of the 12 tumors. No definite trend was appreciated for laterality (7 right-sided tumors and 5 left-sided tumors) or craniocaudal distribution in the kidney (4 upper pole tumors, 2 tumors in the interpolar regions, and 6 lower pole tumors). A preponderance of the tumors was located anteriorly (9/12). The mean tumor size was 4.4 cm, with a range from 1.0 to 10.2 cm; 5 of the tumors were T1a (maximum diameter < 4 cm), 5 were T1b (4 cm ≤ maximum diameter < 7 cm), and 2 were T2 (maximum diameter ≥ 7 cm). Six of the tumors were greater than 50% exophytic, with the remaining six being less than 50% exophytic. Six of the masses were very close to the collecting system (<4 mm), with 2 additional tumors being intermediate in distance from the collecting system (between 4 and 7 mm). The mean tumor R.E.N.A.L. Nephrometry score was 7.3 ± 1.7 .

All of the lesions were solid and well circumscribed. Calcifications were not seen in any of these masses. The tumors were nearly universally spherical in shape, although 1 tumor was noted to be lobulated in contour. Two distinct appearances of overall tumor enhancement were observed. Five of the tumors demonstrated a significantly heterogeneous appearance with punctate, streaky, or peripheral areas of hyperenhancement on a background of tumor tissue that was relatively hypoenhancing in comparison with the enhancement level of the

renal cortex (Fig. 1). Four of the tumors had an appearance very reminiscent of the classic appearance of oncocytomas, with a central hypoenhancing region that may represent a stellate scar (Fig. 2). The remaining 3 tumors were too small to adequately characterize the enhancement pattern.

Table 3 summarizes the attenuation values for the 12 tumors during the noncontrast, arterial, venous, and delayed phases (where available). On average, the tumors in this series were avidly enhancing, although it is noteworthy that the maximum enhancement was generally noted to occur during the venous phase (mean HU attenuation, 124.76 ± 58.70) instead of the arterial phase (mean HU attenuation, 77.40 ± 35.81). The ratios of the maximum tumor attenuation value relative to the aorta, inferior vena cava (IVC), renal cortex, and medulla (arterial and venous phases) and renal parenchyma (unenhanced and delayed phases) are reported. The ratios are as follows: (1) tumor-aorta: 0.57, 0.26, 0.71, and 0.86; (2) tumor-IVC: 0.93, 0.65, 1.42, and 0.93; (3) tumor-cortex: 0.56 and 0.79; (4) tumor-medulla: 1.36 and 1.18; and (5) tumor-parenchyma: 0.72 and 0.95.

Discussion

Renal HOCTs are a rare and indolent tumor type of which we have systematically assessed the CT appearance. Among the interesting findings to arise from this analysis, HOCTs on average demonstrated relatively late enhancement with maximum enhancement occurring during the venous phase. Given the variability in timing of maximum enhancement in other types of renal masses such as clear cell RCCs (a fraction of which also demonstrates maximum enhancement in the venous phase¹²), our findings in this series could simply reflect a clustering effect from the small number of tumors included. This observation could also be related to gradual fill-in of contrast between the arterial and venous phases in the more heterogeneous tumors given our use of whole-tumor regions of interest in arriving at the mean tumor enhancement for each contrast phase. Finally, the relatively late maximum enhancement in these masses could arise as a result of the admixture of the different tumor types composing the mass, given the different enhancement patterns that have been observed in ROs and chRCCs.¹²

A second noteworthy observation is that most of the masses in this series had 1 of 2 qualitative appearances. Figure 3 demonstrates these 2 patterns of qualitative enhancement; in this case, the patient had 2 adjacent right-kidney lower pole lesions, one of which demonstrated the above-described heterogeneous enhancement pattern and the other of which had an “oncocytoma-like” pattern with a central stellate hypodensity. The nature of the origin of these 2 very distinct enhancement patterns is not immediately obvious, although the relative amount of component tissue (RO vs chRCC) in each mass may play a role. A dedicated radiologic-pathologic correlation study could potentially address this possibility.

Hybrid oncocytic/chromophobe tumors are believed to have indolent clinical course.^{1,2,5,13,14} Therefore, patients felt to harbor these lesions might be candidates for less aggressive measures than nephrectomy or partial nephrectomy including thermal ablation or active surveillance. Unfortunately, in our experience, the more aggressive RCC subtypes,

such as clear cell RCCs, can have a remarkably varied appearance including central hypodensity or a very heterogeneous enhancement pattern as a result of necrosis, hemorrhage, calcification, and so forth.^{15–17} Thus, it is unlikely that CT enhancement pattern alone will ever allow the prospective identification of HOCTs. Nonetheless, it is important for practicing radiologists to be aware of the existence of HOCTs and other benign/indolent renal masses that can mimic aggressive tumors. This is because promising, new, noninvasive means of characterizing renal masses are beginning to appear in the literature at both the preclinical¹⁸ and early clinical^{19–21} stages of development. In the near future, it is likely that characterization of renal masses will rely on information from both traditional cross-sectional methods as well as more functional and metabolic aspects of the tumors.²²

The most significant limitations of this work are its retrospective design and the relatively small size. The rare nature of these lesions hinders addressing either of these limitations, although increasing awareness of the existence of these tumors may eventually allow larger studies to be carried out.

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Figure 1.

A 74-year-old man with a right lower pole renal HOCT (white arrowheads) as seen in an axial image from the arterial/corticomedullary phase of a contrast-enhanced CT. This mass demonstrated a heterogenous pattern of contrast enhancement.

Figure 2.

A 63-year-old man with a left upper pole renal HOCT (white arrowheads) visualized on a relatively posterior coronal image from the venous/nephrographic phase of a contrast-enhanced CT. This patient's mass is notable for a pattern of enhancement that mimics the classic description of an oncocytoma with a prominent stellate central hypodensity.

Figure 3.

A 55-year-old man with 2 large right lower pole renal HOCTs abutting each other and seen on an axial image of the arterial/corticomedullary phase of a contrast-enhanced CT. The more lateral of the tumors (white arrowheads) demonstrates central stellate hypodensity (white arrowheads), whereas the more medial of the tumors has a heterogeneous enhancement pattern (white arrows).

Table 1
Patient Demographic Information

Patient	Age, y	Sex	Tumor Laterality	Nephrometry Score
1	63	F	Left	4A
2	71	M	Left	5A
3	73	M	Left	9P
4	55	M	Right	6A
			Right	7A
			Right	7A
5	54	M	Left	9A
6	63	M	Left	10A
7	52	F	Right	7P
8	55	M	Right	8A
			Right	8P
9	74	M	Right	7A

Table 2
CT Morphologic Features of 12 HOCTs

Features	Value
Size, mean (range), cm	4.41 ± 2.98 (1.0–10.2)
Location	
Upper pole	4 (33)
Interpolar	2 (17)
Lower pole	6 (50)
Entire kidney	
Distance from collecting system, mm	
<4	12 (100)
4–7	—
>7	—
Tumor configuration	
Solid tumor	12 (100)
Cystic tumor	—
Tumor heterogeneity	
Homogenous	—
Heterogenous	12 (100)
Central hypodensity	4 (33)
Calcification	None
Well circumscribed	12 (100)

Data are n (%) of tumors, except where noted otherwise.

Table 3
CT Attenuation Values for HOCTs

CT Phase	Attenuation, HU
Noncontrast	
Overall	25.7 ± 5.42
Tumor-to-aorta ratio	0.57 ± 0.23
Tumor-to-IVC ratio	0.93 ± 0.85
Tumor-to-renal parenchyma ratio	0.72 ± 0.23
Arterial phase, 25–30 s	
Overall	77.4 ± 35.81
Tumor-to-aorta ratio	0.26 ± 0.11
Tumor-to-IVC ratio	0.65 ± 0.26
Tumor-to-renal cortex ratio	0.56 ± 0.33
Tumor-to-renal medulla ratio	1.36 ± 0.62
Venous phase, 60 s	
Overall	124.76 ± 58.70
Tumor-to-aorta ratio	0.71 ± 0.28
Tumor-to-IVC ratio	1.42 ± 0.61
Tumor-to-renal cortex ratio	0.79 ± 0.28
Tumor-to-renal medulla ratio	1.18 ± 0.56
Delayed phase, 5 min	
Overall	76.80 ± 25.11
Tumor-to-aorta ratio	0.86 ± 0.18
Tumor-to-IVC ratio	0.93 ± 0.18
Tumor-to-renal parenchyma ratio	0.95 ± 0.43