

## **Solid renal masses: use of spiral Computed tomography for Differentiation between benign and malignant lesions.**

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### **المخلص**

اجريت دراسة مقطعية لثمانين مريضاً يشتبه بإصابتهم بتكتل بالكلية، تم فحصهم بالسونار لتشخيص كون التكتل كيسي أم صلب، تم إجراء المفراس الحلزوني لحالات التكتل الصلب قبل العملية، حيث اعتبرت المعايير الآتية أساساً في التمييز كون التكتل حميد أم خبيث (نوعية ودرجة أخذ التكتل الصلب للصبغة، قابليته على تكوين الأوعية الدموية، وقياس درجة التكلس). أظهرت هذه الدراسة أن التكتل الذي يحتوي على الخراج بعد إجراء المفراس الحلزوني له يمكن تشخيصه بأن له قابلية على أخذ الجدار فقط للصبغة بينما الورم الخبيث له قابلية مختلفة لأخذ الصبغة بالإضافة إلى ذلك، الورم الخبيث له قابلية عالية على تكوين الأوعية الدموية، بينما الورم الحميد له درجة متوسطة على أخذ الصبغة. نستنتج من هذه الدراسة هناك بعض الفحوصات ودرجة أخذ الورم التكتلي الكلوي للصبغة بإمكانها أن تميز كون التكتل الكلوي حميد أو خبيث.

### **Abstract**

**objective:** To determine whether CT images on the basis of their morphologic features and enhancement patterns. could help accurately distinguish benign renal masses from malignant .

**patients and Methods :** Between April 2006 and February 2009, 80 consecutive patients (age range, 1–65 years; 50 male, 30 female) suspected to have renal mass by physical examination ,underwent ultrasound examination to evaluate the mass ,whether cystic or solid. Only patients with solid renal mass documented with US were included in the study then preoperative renal CT. All CT studies evaluated the mass about the pattern and degree of enhancement, lesion contour, presence of neovascularity, and calcifications .

**Results:** Of the 80 renal masses (median size, 3.4 cm; range, 1.1–20.0 cm) included in this study, 30 (37 %) were benign and 50 (63 %) were malignant. of benign 14 (47%)patients have abscess and 16(54 %) have angiomyolipoma , while malignant tumor classified as clear cell renal cell carcinomas (RCCs) 28 (56 %) , papillary lesions 16 (32 %) and 6 (12 %) Wilm's tumors. abscess most commonly classified as hypodense with peripheral enhancement while Clear cell RCC most commonly manifested with a mixed enhancement pattern of both hypervascular soft-tissue components and low-attenuation areas that corresponded to necrotic or cystic changes ,whereas the homogeneous and peripheral enhancing patterns were more predictive of less aggressive papillary .

Clear cell RCCs tended to be hypervascular and angiomyolipomas tended to enhance moderately, and papillary lesions were mostly hypovascular.

**Conclusion:** Certain imaging features and the degree of enhancement may be helpful in differentiation of renal masses .

### **Introduction**

Renal masses can be broadly categorized into cysts, tumors and inflammatory lesions. Although simple cysts are usually asymptomatic, they occasionally cause flank or abdominal pain, a palpable abdominal mass or hematuria. Malignant masses may produce the same symptoms, or they may be associated with paraneoplastic syndromes. Inflammatory lesions are not usually incidental because there is almost always an associated clinical history when symptoms are present. A history of fever, chills or urinary tract infection suggests an infected cyst or an abscess.<sup>(1)</sup>

Sonography is clearly superior to excretory urography for both detection and characterization of renal masses, and CT is superior to sonography for these tasks (2), however, the role of MR imaging in evaluating renal masses remains uncertain. Most studies indicate that optimal MR imaging is comparable with optimal CT for detection, diagnosis, and staging of renal masses<sup>(3)</sup>CT requires the injection of IV contrast material, which may be unacceptable for a small percentage of patients. CT has the advantages of widespread availability, more rapid examination time in comparison with MR imaging, and lower cost than MR imaging. MR imaging is particularly useful for patients with contraindications to receiving IV radiographic contrast media<sup>(3)</sup>.

The Bosniak classification system is used to assess the likelihood of malignancy in cystic renal masses on the basis of lesion complexity<sup>(4)</sup>. This classification system has been used to guide clinical management of cystic renal masses. Although it is important to preoperatively differentiate a solid renal tumor for treatment planning and patient counseling, there are no well-established imaging criteria which help in diagnosis renal mass<sup>(5)</sup>. Thus, assigning a definitive diagnosis on the basis of biopsy findings may be a challenge because it can be difficult to distinguish an RCC with sarcomatoid features from the spindle component of an angiomyolipoma<sup>(5,6,7)</sup>. It has been suggested that certain imaging features may be associated with different subtypes of solid renal cortical tumors<sup>(8,9,10,11,12)</sup>. Thus, the purpose of this study was to determine if the renal masses depicted on computed tomographic (CT) images can be differentiated on the basis of their morphologic features and enhancement patterns or not .

## **Patients and Methods**

**Patients:** Between April 2006 and February 2009, 80 consecutive patients (age range, 1–65 years; mean age, 55 years; 50 male, 30 female) table (5,8) with solid renal masses by ultrasound examination table (4), underwent preoperative renal CT scanning in department of radiology in Hilla teaching hospital followed by operative exploration with nephrectomy in all cases except patients with abscess drainage were done in department of urology in the same hospital. The median time from scanning to surgery was 35 days (range, 2 days to 70 days). between initial CT scanning and surgery.

**CT Examination:** Contrast –enhanced CT scans covering the area from the diaphragm to the ischial tuberosities were obtained. Incidental renal masses may also be detected on the standard abdominal CT scan. The current "gold standard" for evaluating renal masses requires capturing CT images (5 mm or less in thickness) before and after (no less than 100 seconds) contrast medium is administered. The density of a renal mass is reported in Hounsfield units (H.U). The Hounsfield measurements of the relative densities of various substances, including tissues..all CT examinations were performed with four detector row helical scanners . CT images were obtained during patient breath holding with the following parameters: 120 kVp, 200–400 mA (depending on patient size), and section thickness and reconstruction interval of 2.5 mm through the kidneys and 5.0 mm through the rest of the abdomen. The pitch used with helical scanners varied for different scanners but ranged from 0.75 to 1.5. All patients received oral contrast material 30 minutes before CT. Unenhanced, parenchymal phase, and excretory phase images were obtained through the kidneys. The entire abdomen (and pelvis, if requested) was scanned during the parenchymal phase only. A 150-mL dose of nonionic intravenous contrast material (iohexol 300, Omnipaque ) was administered with a power injector at a rate of 2.5 mL/sec (or slower if mandated owing to suboptimal venous access). Time delay to scanning varied with the type of scanner used but was determined on the basis of the typical time to the renal parenchymal (70–85 seconds) and excretory (3 minutes) phases.

**CT Image Analysis :** For each of the renal masses, it was evaluated the largest lesion for several features. The first feature evaluated was pattern of enhancement. The enhancement pattern of the tumor was classified as homogeneous (Fig 1) or heterogeneous. The heterogeneous tumors contained a mixture of solid enhancing soft-tissue components and low-attenuation areas that might have represented necrotic or cystic changes. Heterogeneous tumors were further categorized into three types on the basis of the relative proportion of solid areas to low-attenuation areas: solid or predominantly solid lesions with small areas of low attenuation Fig (2), lesions with mixed solid and low-attenuation areas, and predominantly low-attenuation lesions with peripheral

enhancement. The second feature evaluated was degree of enhancement. For heterogeneous lesions differentiation in HU, selecting the area that demonstrates the greatest degree of enhancement of the renal lesion on the parenchymal phase images. Matching round or elliptical regions of interest approximately 0.1 cm<sup>2</sup> in size were placed in this area on unenhanced and parenchymal and delayed phase images Fig (3). Regions of interest were also placed in the adjacent normal renal cortex and aorta for normalization. For homogeneous lesions, regions of interest were placed in the center of the mass. Areas containing calcifications or artifacts were avoided. The third feature evaluated was neovascularity. Recruitment of tumor vessels—evidenced by increased numbers and irregular vessels adjacent to the affected kidney within Gerota fascia, with frequent arteriovenous shunting—was present or absent. The fourth feature evaluated was contour of renal masses. Lesion contours were classified as smooth, lobulated, or irregular. The fifth feature evaluated was calcification. When present, the location (rim or center) of calcification in the mass was recorded.

**Operative procedure:** Under general anesthesia all patients underwent exploration by anterior approach with chevron incision used peritoneum opened with mobilization of colon, in cases of tumor the standard radical nephrectomy proceeded with complete removal of mass with kidney, Gerota fascia, adrenal gland and upper ureter, the drain left and wound closed in layers. In case of suspected abscess aspiration of mass if pus come out, the drainage of abscess done retroperitoneally with wide bore tube drain left inside abscess cavity

## Results

Eighty patients presented in Hilla teaching hospital of having different presentation table (1) show clinical presentation of each patient, then ultrasound examination done for all of them, by ultrasound examination found the patients to have solid renal mass, then underwent CT examination in department of radiology in Hilla Teaching Hospital table (2) show attenuation finding of renal mass by computed tomography, follow by operative exploration in department of urology in the same hospital during period April 2006 and February 2009. All patients underwent operative exploration with histopathological examination and compare with preoperative CT examination. table (6). 50 (62%) were malignant and 30 (38%) were benign. the sensitivity of computed tomography to diagnose malignant renal mass 80% while the specificity 84% (table 3). the 50 malignant lesions, 28(61%) were clear cell RCC; 16 (17%), papillary RCC; and 6 of the 50 malignant lesions were wilm's tumor fig.(7), The 30 benign lesions included 14 abscess (67%), 16 angiomyolipomas, 10 of them demonstrate appreciable fat on CT images and 6 of them demonstrated minimal amount of fat on CT image but in all cases in

which the diagnosis still suspicious they underwent nephrectomy and final diagnosis proved by histopathology .. The median lesion size was 6.4 cm (range, 4.1–20.0 cm). age of patients (table 5),side of renal mass (table 4),but unfortunately we haven't face a tumor like oncocytoma ,lipoma ,renal sarcoma and adenoma.

**Features:**There was a significant association between lesion type(table 6) and (a) homogeneous or heterogeneous enhancement pattern, (b) type of contour, and (c) observed neovascularity Furthermore, there was moderate to goodenhancement that clear cell RCCs most commonly manifested with a mixed enhancement pattern of both enhancing soft-tissue components and low-attenuation areas that may have represented necrotic or cystic changes however, When grouped together, homogeneous and peripheral enhancement patterns were seen most commonly in papillary RCCs Fig. (1). The pattern of enhancement whether homogenous or heterogeneous enhancement pattern , that the presence of a heterogeneous pattern may increase the probability that a malignant lesion is aggressive Fig.( 2). In addition, the absence of a heterogeneous pattern , indicating that the absence of this pattern or the presence of a homogeneous pattern is more indicative of less aggressive disease . Less aggressive tumors were more likely to have smooth contours while irregular contour more aggressive Fig(3) . The patterns of heterogeneity and calcification were then analyzed in greater detail table (6). The pattern of heterogeneity identified was significantly associated with the aggressiveness of the renal tumor . A heterogeneous and mixed pattern was more likely to represent aggressive disease , whereas peripheral enhancing lesions were more likely to represent less aggressive disease Fig (4). The presence and location(s) of calcification were not significantly associated with aggressiveness of disease Fig (5).

**Table -1: Clinical presentation of patients**

Clinical featur	No.
haematuria	50
Renal pain & fever	15
Palpable loin mass	9
Urinary symptom	6
total	80

**Table- 2: Attenuation finding of renal mass in computed tomography examination**

Renal mass	N.	hypodense	isodense	hyperdense
Clear cell carcinoma	28	6	17	4
Papillary cell carcinoma	16	4	8	4
Wilm s tumor	6	1	3	1
angiomyolipoma	16	8	1	7
abscess	14	7	3	4
total	80			

The attenuation of the renal parenchyma typically ranges from 30 to 40 HU; that of hyperattenuating renal masses usually is at least 40 HU but no higher than 90 HU(1).Hypodense mass <30, Isodense mass 30-40, Hyperdense mass >40.

**Table -3: Validity,positive and negative predictive value for diagnosing malignant renal mass**

	Malignant	Benign	total
CT positive	TP 40	FP 5	45
CT negative	FN 10	TN 25	35
Total	50	30	80

Sensitivity : $TP/TP+FN = 40/40+10 * 100=80\%$

Specificity : $TN/TN+FP = 25/25+5 * 100=84\%$

Positive predictive value  $TP/FP+TP = 40/5+40 * 100=89\%$

Negative predictive value : $TN/TN+FN = 25/25+10 * 100=72\%$

- TP:true positive
- TN:true negative
- FP:false positive
- FN:false negative

**Table- 4:The side involved by renal mass**

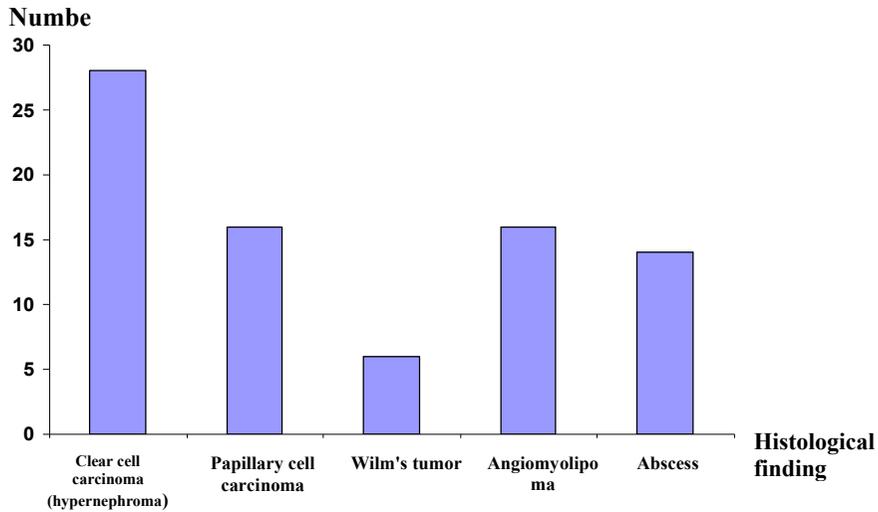
side	number
Left	48
Right	32

**Table- 5: Distribution of renal mass in relation to sex**

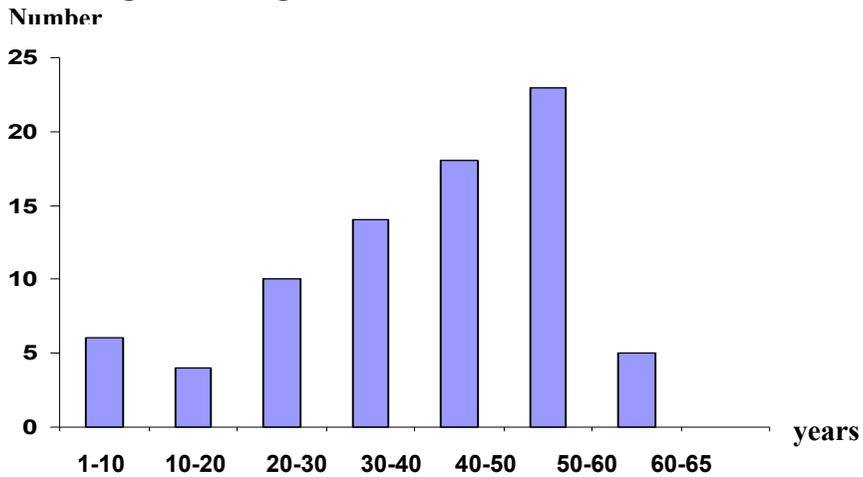
Sex	number
Male	50
Female	30

**Table- 6: Features Identified by CT Summarized according to Histologic Type**

Tumor	Nu.	Homogenous enhancement		Heterogenous enhancement			contor		Calci.	
		mild	moderate	Avid	mixed	peripheral	neovascularity	smooth		irregular
Clear cell carcinoma	28	0	0	0	24	4	27	8	20	3
Papillary cell carcinoma	16	4	4	0	0	8	7	9	7	1
Wilm's tumor	6	0	0	0	5	1	5	2	4	2
angiomyolipoma	16	0	6	0	10	0	6	12	4	0
Abscess	14	0	0	2	4	8	0	1	13	1
total	80									



**Fig.7 :histological finding of renal mass**



**Fig.8 :Distributions of renal mass in relation to age of patients**

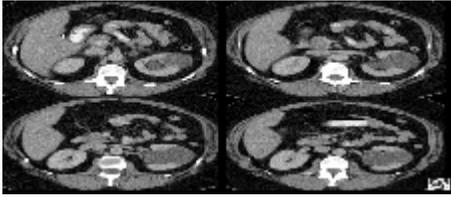


Figure 1: Transverse native material-enhanced CT images In a 53-year-old man with an incidentally discovered renal mass, surgical pathologic analysis.

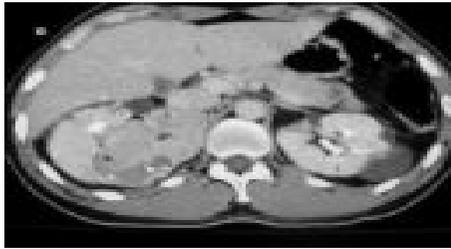


Figure 2: Transverse contrast material-enhanced CT images . In a 50-year-old woman with an incidentally discovered renal mass, surgical pathologic analysis revealed clear cell RCC. The tumor (arrow) demonstrates a predominantly solid enhancement pattern, with small low-attenuation foci that may represent necrosis or cystic changes.

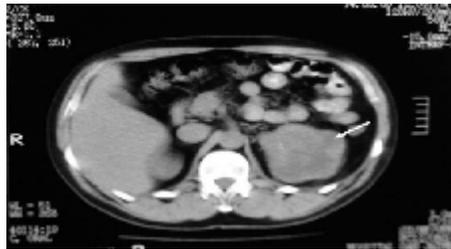


Figure 3: Unenhanced transverse CT images obtained in a 48-year-old man with clear cell RCC. To assess mass used visual assessment within the mass to evaluate the images to select the area that appeared.

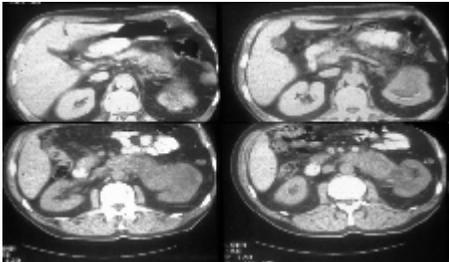


Figure 4: Transverse contrast material-enhanced CT images .In a 34-year-old male with an incidentally discovered renal mass, . The tumor (arrow) demonstrates a low degree of peripheral enhancement (maximum attenuation, 85 HU) and central low attenuation. Surgical evaluation confirmed abscess.

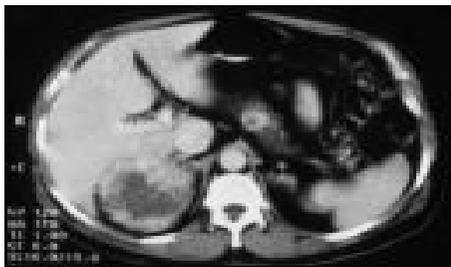


Figure 5: Contrast-enhanced transverse CT image obtained in the renal parenchymal phase in a 55-year-old woman with a right renal mass (arrow) The mass has central low attenuation ,with central small calcification and a relatively low degree of peripheral enhancement (100 HU) compared with renal cortex enhancement (194 HU). A diagnosis of papillary RCC was assigned at surgical pathologic analysis.

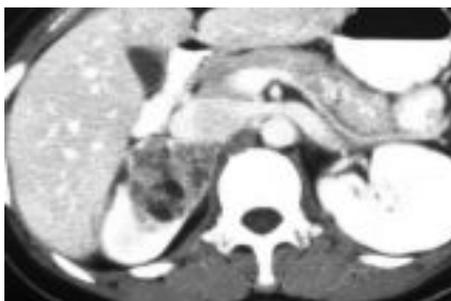


Figure 6: Contrast-enhanced transverse CT image obtained in the renal parenchymal phase in a 68-year-old woman with a right renal mass (arrow) discovered incidentally during evaluation of abdominal pain . The mass has a heterogeneous mixed enhancement pattern, and a diagnosis of angiomyolipoma was assigned at surgical pathologic analysis.

The advent of multidetector CT has led to better detection and earlier diagnosis of renal tumors <sup>(5,6)</sup>. To differentiate renal mass wither benign or malignant multiple criteria must be seen(attenuation ,enhancement ,degree of enhancement ,calcification and contour )

The most important criterion used in differentiating surgical from nonsurgical renal masses is the determination of enhancement

When the predominant part of a renal mass enhances, the mass is considered solid and likely neoplastic. However, vascular anomalies, aneurysms, and focal inflammatory processes should be excluded before a neoplasm is considered. Vascular anomalies and aneurysms show enhancement similar to that of arteries or veins and typically greater than that of solid masses. Focal inflammatory processes include changes due to infection, trauma, and infarction. Focal bacterial pyelonephritis usually can be diagnosed by noting that the mass has ill-defined margins <sup>(7,8)</sup> and is associated with abundant perinephric fat stranding. A history of an ongoing urinary tract infection usually can be elicited from the patient. Similarly, a history of renal trauma is nearly always present in the case of a renal contusion. . When infection, trauma, and vascular abnormality have been excluded, an enhancing hyperattenuating renal mass is neoplastic.

Angiomyolipomas consist of variable quantities of blood vessels, smooth muscle, and fat. Most angiomyolipomas can be diagnosed by identifying portions of the mass with an attenuation of -10 HU or less, which is indicative of fat <sup>(9)</sup>. However, approximately 4%–5% of angiomyolipomas either do not contain any fat cells or contain an insufficient amount of fat cells to allow a diagnosis based on imaging <sup>(10)</sup>; these angiomyolipomas with minimal fat consist mostly of smooth muscle and are typically hperdense.

In general, any enhancing solid mass in the kidney should be considered a renal neoplasm but not necessarily malignant . In most cases but not all , it is possible to differentiate preoperatively those renal masses that require surgery (malignant renal tumor from those that do not ,so we need exploration of all patients and histopathological examination . . angiomyolipoma and abscess can all mimic renal cell carcinoma so preoperative diagnosis is difficult .

The imaging characteristics of renal cell carcinoma are extremely varied, with masses ranging from cystic to solid, from homogeneous to heterogeneous and necrotic, from small to large, and from localized to extensive Fig ( 4). Renal cell carcinomas can range from small, slow-growing, incidentally discovered lesions to aggressive neoplasms that may metastasize.

The differentiation of an angiomyolipoma from a renal cell carcinoma is important because, in most cases (excluding very large lesions or those that are bleeding), angiomyolipomas do not need to be surgically removed. The diagnosis of an angiomyolipoma is made by demonstrating fat within a solid renal mass <sup>(9)</sup>.

In this study differentiation of renal cell carcinoma from angiomyolipoma depend on present of fat this finding is the same finding notice by Bosniak<sup>(10)</sup> Detecting the existence of fat in a renal lesion will establish the diagnosis of angiomyolipoma and is the only radiologic finding that can differentiate it from renal cell carcinoma ,finding of this study 10 pateint of angiomyolipoma have large amount of fat and six patient have minimal amount of fat The fat content of the lesion was appreciated because tissue attenuation measurements of small areas of low attenuation within the tumors were performed and because thin-section (5-mm) and nonenhanced CT scans were used. In this six patient of angiomyolipoma with minimal fat all showed homogeneously high attenuation on unenhanced CT images, homogeneous enhancement on contrast-enhanced CT images this is the same finding by Jinzaki et al<sup>(11)</sup> Zhang et al<sup>(12)</sup>, who find that angiomyolipoma with minimal fat have high attenuation with homogenous enhancement postcontrast study .

our study shows that calcification was seen mostly in malignant renal tumors, although the pattern of calcification not predictive of the aggressiveness of disease. This is consistent with the findings of studies in the 1970s by Daniel<sup>(13)</sup> which showed that calcification in renal masses on radiographs indicated malignancy .

There have been a few case reports of fat occurring in renal cell carcinomas that also contain calcification<sup>(14,15)</sup>.in this study angiomyolipomas rarely contain calcification the same finding by Hammadeh who said Angiomyolipomas rarely contain calcification<sup>(16)</sup>, and, therefore, a diagnosis of angiomyolipoma should not be made if a lesion contains fat and calcium. In such cases, a renal cell carcinoma must be considered likely. Rarely, a large renal cell carcinoma may contain a small amount of fat, and differentiating this from an angiomyolipoma is impossible<sup>(17,18)</sup>. Finally, it is also possible that a large renal cell carcinoma may engulf a small portion of fat in the renal sinus or perinephric fat, or even a small adjacent angiomyolipoma, giving the appearance of a larger angiomyolipoma containing a small amount of fat. It may not be possible to distinguish these types of masses from each other so we depend on operative finding with nephrectomy in all suspected cases and final result depend on histopathological examination .

The results of some studies indicate that certain imaging features may be associated with specific subtypes of renal tumor<sup>(19)</sup>. The most consistent finding (found by Herts et al<sup>(20)</sup>, Kim et al<sup>(21)</sup>, Ruppert-Kohlmay et al<sup>(19)</sup>, and Sheir et al<sup>(22)</sup>) was that degree of enhancement was the most valuable parameter for differentiation of malignant renal` mass , as clear cell RCCs enhance to a greater degree than other subtypes of malignant lesions, especially papillary RCCs<sup>(17)</sup>.

In present study we found that enhancement and degree of enhancement is most important feature to differentiate renal tumor

that clear cell carcinoma mixed heterogeneous enhancement of both enhancing soft-tissue components and low-attenuation areas that may represent necrotic or cystic changes (On the other hand, when homogeneous or peripheral enhancement patterns are present, RCC is a less likely diagnosis, and other cell types should be considered. Notably, a majority of papillary tumors were either homogeneous or demonstrated peripheral enhancement this finding consist with finding by Herts et al <sup>(20)</sup> found that papillary RCCs are typically homogeneous, . Since renal tumors are often heterogeneous, we decided to measure the areas of greatest enhancement in the lesion rather than in the entire tumor. We believe that measurements obtained with this approach minimize volume averaging effects from areas of cystic or necrotic changes and truly reflect the vascularity of the tumor those with avid enhancement (suggestive of clear cell RCC , moderate enhancement (suggestive lipid poor angiomyolipoma), and mild enhancement (suggestive of papillary RCC ) . The degrees of enhancement of the tumor overlapped substantially more in the precontrast and excretory phases. As suggested previously by Bosniak <sup>(11)</sup>, the measured attenuation of the renal lesions should be normalized by using the measured attenuation of either the renal cortex or the aorta to ensure that attenuation is independent of technical or patient variability ).

The result found hypervascular pattern was more prevalent in clear cell carcinoma 97% while papillary RCC 44% this finding was consistent with the findings of the studies cited previously <sup>(8,9,10)</sup> also consistent with finding by Sheir et al <sup>(22)</sup> who found hypervascular pattern (higher tumor enhancement after contrast material injection due to higher vascularity) was noted in 48.6% of clear cell subtype in comparison to 15.4% of papillary .

The present study showed that the presence of irregular contour was mildly associated with a more aggressive tumor and that smooth contour was associated with a less aggressive tumor, however the abscess has irregular contour so this sign is not predictive of aggressiveness . However, none of these additional features (either alone or in combination) was useful as the enhancement pattern in predicting tumor subtypes.

Current patterns of imaging utilization lead to frequent serendipitous discovery of renal lesions. Today, the majority of solid renal masses that are ultimately proved to be renal cell carcinomas were incidental findings on imaging studies performed for non-urinary tract symptoms. While earlier discovery has led to treatment of smaller and earlier-stage malignancies, the percentage of benign lesions discovered has also increased.<sup>(23)</sup>

## Conclusions

On the basis of the findings, we conclude 1- that certain imaging features and the degree of enhancement on CT images are helpful in differentiating renal masses, despite some overlap between the renal masses whether benign or malignant (as result can not depend on CT preoperatively to decide not to do surgery ).2- Thus, imaging findings may contribute incremental value to clinical parameters in providing prognostic information, consequently improving the quality of the data used in therapeutic planning.

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