Preoperative Assessment of Solid Renal Tumor by Computed Tomography

Mohamed T. Yahya[1], Husham A. Thanon[2], Wadhah M. Hammo[3], Mahmod B. Mahmod[4]

[1]M.B.Ch.B., C.A.B.H.S., XRay department of Ibn Sina Teaching Hospital, MOSUL, IRAQ
[2,3,4]M.B.Ch.B., D.M.R.D., XRay department of Ibn Sina Teaching Hospital, MOSUL, IRAQ

ABSTRACT

Background and purpose: To evaluate the accuracy of computed tomography in preoperative assessment of solid renal tumor concerning types, and staging on basis of radiological features of the tumor.

Methods: This is a prospective study conducted upon 55 patients whose age range from 6 months to 81 years old. The examinations were done in hospital of Erbil teaching centre in department of radiology. The period was between December 2010 to January 2012. The patients were referred to CT unit for evaluation of suspected case of solid renal mass. In all patients Computed tomography were done pre and post intravenous contrast and delay after 10 minutes imaging were obtained and lesion where analyze on basis of size, density, enhancement, extension, lymph node and vascular involvement, and metastases and final diagnosis obtained based in histopathology study.

Results: of the 55 cases. 40 (72.7%) were renal cell carcinoma, 4 (7.2) were Wilms tumor, 2 (3.6%) transitional cell carcinoma, 2 (3.6) lymphoma, 1 (1.8%) metastases, 5 (9.2%) angiomyolipoma, 1 (1.8%) oncocytoma. The malignant lesions as a whole were (89%) and benign mass (11%). 1. The sensitivity, specificity, accuracy, negative predictive value, positive predictive value in diagnosis of RCC were 100%, 86.6%, 96.3%, 100%, 95.2% respectively. Conclusion: Computed tomography is accurate in preoperative assessment of solid renal tumor considering characterization, extension and staging.

Key wards: Solid Renal Tumor, Computed Tomography, Renal Cell Carcinoma, TNM, Malignancy, Radiology.

INTRODUCTION

Anatomy

In the typical patient, there are two kidneys, each of which consists of a peripheral cortex, central medulla, renal sinus fat, vessels, and urothelial structures. The kidneys are located within the retroperitoneal space to each side of the vertebral bodies at the level of T10-L2. The kidney margins are generally smooth. Renal length is relatively stable at 9 to 13 cm from ages 20 to 50 and gradually decreases thereafter. The extensions of cortex between the renal pyramids are given a special name: the columns of Bertin. [1-4]

Anatomy in CT: On CT, the transverse contour of the kidney is smooth and oval, with an anteromedial break in the renal outline at the hilus where the vascular pedicle enters. The renal fascia is commonly visualized on CT, especially when the fascia is thickened. [2,4]. The densities of the renal medulla and renal cortex on non-enhanced CT are very similar, and they are similar to the attenuation of the liver. The normal renal parenchyma is of intermediate density, measuring between 30 and 60 HU on non enhanced CT. [1,5]. The central renal sinus has fat attenuation with linear fluid-attenuation renal vessels coursing from the aorta and toward the inferior vena cava. [1]

Four distinct phases of renal enhancement canbe imaged depending on acquisition time. The timing of these phases varies with the speed of intravenous contrast injection. We routinely inject100–120 ml of non-ionic contrast in a large antecubitalvein at a rate of 3 ml/s.[6].The arterial phase: During this short phase, which occurs at about 15–25 s after the initiation of intravenous contrast injection, there is maximum opacification of the renal arteries. The renal veins also usually opacify in the late arterial phase. This phaseis important for imaging potential renal donors orpatients with suspected renal

arterial pathology. [6]. The structure of the kidney is best demonstrated at the "cortico-medullary phase," which is at approximately 40 seconds following the intravenous administration of iodinated contrast medium. There is intense enhancement of the renal cortex, while the medulla remains relatively less enhanced. This phase provides information about the vascularity of solid renal masses and is also the best phase for maximum opacification of the renal veins.[6-7].

The homogeneously dense nephrographic phase is achieved later about 80 seconds and lasts up to 180 seconds after the start of injection, and it offers the best opportunity for discrimination between the normal renal medulla and a renal mass. The nephrographic phase is the most valuable for detecting renal masses and characterizing indeterminate lesions. When the cortex and medulla are evenly enhanced, the medulla may eventually even be of higher attenuation than the cortex. [4,8].The collecting system including calyces, infundibula, and renal pelvis seen in excretory or urographic phase typically begins 3 to 5 minutes after injection. At this time, the renal medulla may be slightly more enhanced than the cortex as contrast is excreted from the renal tubules. During the excretory phase, dense contrast fills the collecting systems, the ureters, and eventually the urinary bladder. [1,9]. CT urography is a relatively new technique that is progressively replacing conventional intravenous urography (IVU). It is being increasingly used for indications such as hematuria of unknown cause because of its ability to examine the entire genitourinary tract in a single study. However, it remains limited in evaluation of the urothelium compared with IVU because of its lower spatial resolution. [4]

CT urography allows a contrast medium–enhanced reconstructed view of the ureters. This technology is dependent on the imaging and processing capabilities of the scanner and workstation, and most modern scanners have the capability of producing excellent images. The technique involves capturing traditional cross-sectional images from the helical scanner during the late excretory phase. The images are reconstructed into a CT urogram with a similar gross appearance from that of IVU. [3]

Role of the CT in renal tumor: CT quickly emerged as a powerful tool in the diagnosis of many diseases of the urinary tract, including renal masses. Plays a crucial role in the diagnosis, management, and follow-up. [10-11]. The traditional role of diagnostic imaging in patients with a renal mass is to detect and characterize the mass and to stage neoplastic disease. Computed tomography is a rapid, easily performed, and safe diagnostic imaging technique that provides valuable information about a wide spectrum of renal disorders. CT is highly accurate for determining the nature and extent of renal masses and plays a valuable role in assessing patients with renal cystic disease, renal trauma, renal infections, renal blood flow disturbances, and hydronephrosis of unknown cause. Multidetector CT (multislice CT) promises to provide even more rapid assessment of the kidneys and a higher accuracy in the evaluation of renal masses and of the renal blood vessels than is provided by single-detector helical CT. [4,12]

The main advantages of CT include a wide field of view, the ability to detect subtle differences in the x-ray attenuation properties of various tissues, good spatial resolution, anatomical cross-sectional images, and operator independence. [13] Renal blood supply and drainage: Five or six veins arise within the kidney and join to form single renal vein in 85%, which runs anterior to the artery within the renal pelvis. The right renal vein has a short course, running directly into the IVC. The left renal vein runs anterior to the abdominal aorta and then drains into the IVC. The left renal vein receives tributaries from the left inferior phrenic vein, the left gonadal and the left adrenal vein. [6,14] . The main renal arteries originate laterally from the aorta, level of the superior margin of L2 just below the origin of the superior mesenteric artery. [2,14]

Solid Renal tumor: In general, any enhancing solid mass in the kidney should be considered a renal neoplasm. However, it should also be kept in mind that all enhancing solid renal masses do not represent a renal neoplasm. [15]

Renal tumors are a common clinical problem, often detected in asymptomatic patients. Kidney tumors are classified as benign or malignant depending on their histopathological features. [7,9].Over the past decades, investigators have proposed several classification schemes for renal masses, although not one has been universally accepted as being both simple and comprehensive. [11]

Renal cell carcinoma (RCC):

Renal cell carcinoma is the commonest renal malignancy, comprising 85% of all malignant renal tumors. It occurs bilaterally in 3–5% of cases, accounting for 3% of newly diagnosed neoplasms. The peak age of incidence is the sixth decade, and there is a male-to-female preponderance of 3:1. [16,17]. The tumor is rare in children. Less than 2% of all cases of renal cell carcinoma occur in pediatric patients, with 4% are familial.[3,18]. Clear cell RCC is the most common subtype (70%) and has a less favorable prognosis than do papillary RCC (13%-15%) and chromophobe RCC (5%). [19-20]. Predisposed factors include Von Hippel-Lindau syndrome (25%) which consist of multiple often small intracystic tumors (hemangioblastoma, retinal angioma, renal cysts) manifesting at a young age. Other predisposing factors such as hemodialysis (in 1.4-2.6%), acquired cystic disease of uremia (3.3-6.1%) and tobacco. [14]. Clinically the most common

presentations are hematuria (50–60%), pain (40%), and a palpable abdominal or flank mass (30–40%), with the entire triad present in only about 10–20% of patients. More than 50% of these tumors are presenting as asymptomatic incidental findings on IVU, abdominal ultrasound, or CT scans.[7,21]. The radiological features of RCC are well marginated often lobulated solitary mass, focal bulge in renal contour, enlargement of affected part of the kidney. Calcification is seen in 15-20% usually central and amorphous or peripheral curvilinear in cystic RCC. Neoplasms may be hypodense, isodense , or hyperdense compared with normal renal parenchyma on nonenhanced CT scans. [4,14]. Approximately 5% to 10% of instances of renal RCC have a cystic appearance (2%-5% are predominantly cystic). [9,22]

After administration of intravenous contrast medium, most RCCs enhance, but usually to a lesser extent than normal renal parenchyma. Enhancement is often heterogeneous because of tumor hemorrhage or necrosis. Small RCCs, however, often have distinct, smooth margins. [4]. Finally, it is also possible that a large RCC 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. [15]. Frank invasion and perforation of the collecting system or renal capsule are found in approximately 20% of cases, although displacement of these structures is a more common finding.[3].

Tumor growth into the renal vein occurs in 30% of cases and extension into the IVC in 5% to 10% of cases. Detection of venous invasion is critical to surgical planning. The thrombus often is vascular and may show arterial enhancement.[1-2]. Extension of tumor into perirenal fat or adjacent liver spleen, or paraspinous musculature; interruption of perirenal fascial planes; and perihilar and per vascular adenopathy can be assessed accurately on good-quality CT images. [23]. Infiltrative pattern of RCC can be seen but this type of tumor is quite rare, probably representing about 1%-2% of renal cell carcinomas in both radiologic and pathologic series. [24]. The TNM system is the most widely used system for staging renal cancer and is shown in (Table 1). [57]

Table 1: Staging of RCC: TNM system

Disease extent	
Tumor confined to kidney, < 4 cm	T1a
Tumor confined to kidney > 4cm,but < 7 cm	T1b
Tumor confined to kidney > 7 cm	T2
Tumor confined to kidney < 7cm but not <10cm	T2a
Tumor confined to kidney < 10 cm	T2b
Tumor spread to renal vein , perinephric fat	T3a
Tumor spread to IV cava infra diaphragm	T3b
Tumor spread to IV cava above diaphragm	T3c
Tumor spread out side Gerota's fascia	T4
No nodal involvement	N0
Metastases to regional lymph node(s)	N1
No distant metastases	M0
Distant metastases	M1

Oncocytoma:

Renal oncocytoma is an uncommon 3% to 6% of renal neoplasms. Although renal oncocytoma is often detected as an incidental renal mass in an asymptomatic adult, it must be differentiated from other renal tumors, particularly renal cell carcinoma. [2,25]

Oncocytomas typically appear as well defined sharp border mass and homogeneous with central scar in CT or spoke-wheel appearance in angiography. [22]

Lymphoma:

Renal lymphoma is most often seen in conjunction with multisystemic, disseminated lymphoma or as tumor recurrence. renal lymphoma may also be seen in immunocompromised patient or rarely, as primary disease. [26]

The incidence of renal involvement in patients with lymphoma ranges from 34% to 62% in several autopsy series. Imaging studies underestimate the incidence of renal involvement, with CT detecting renal disease in only 3-8% of patients with known lymphoma. [27]. The pattern of appearances in children showed similar characteristics to that described in adults; however, the appearance of multiple, bilateral renal masses was heavily prevalent in children. [28.] The most common pattern of renal lymphoma detected at imaging is that of multiple bilateral renal masses. Other less common forms of involvement include solitary mass, direct invasion of renal parenchymal involvement from retroperitoneal and renal hilar lymphadenopathy, and a perirenal rind of soft tissue. [29]

Angiomyolipoma (AML):

Renal angiomyolipoma (AML) is typically a solid lesion, composed of adipose tissue, dystrophic vessels, and smooth muscle cells, lacking an epithelial component. This unusual benign tumor accounts for 3% of all solid kidney tumors, with a female predominance (sex ratio 4: 11) between 40-70 yr. It can occur sporadically in 80-90% which is usually focal and unilateral or in association with phacomatoses (20%) AMLs associated with Tuberous Sclerosis TS are usually bilateral and multifocal, and can occur at any age and in either sex. [30-31.] Most common signs and symptoms are asymptomatic, incidental CT finding, hematuria, flank pain or palpable flank mass, acute abdomen (spontaneous hemorrhage, rupture). Occasionally hypertension & chronic renal failure. [32.]

Imaging Features The key diagnostic feature of angiomyolipoma is the presence of areas of fat attenuation (less than -20 HU) within the tumor at CT 95% (minimal-fat AML in 5%). A varying amount of soft tissue is also visible and determines the degree of enhancement of the lesion after intravenous administration of contrast material. [14,33]

Metastases:

The kidney is a common site of metastases, with reported incidences of 2 to 20% at autopsy. The tumor that most commonly metastasizes to the kidney is lung carcinoma. Other tumors include breast, stomach, melanoma, and contralateral renal cell carcinoma. [34]

Transitional cell carcinoma (TCC):

Urothelial cancers of the renal pelvis and collecting system constitute approximately 10%–15% of all renal tumors: 90% are transitional cell carcinoma (TCC), 9% are squamous cell carcinoma, and 1% are mucinous adenocarcinoma. Most tumors occur in the 6th and 7th decades of life, with males affected three times more often than females. [35] . The hallmark of TCC is multiplicity and recurrence. Nearly 2–4% of patients with bladder cancer develop upper tract TCC, but 40% of patients with upper tract TCC develop bladder cancer. [36]

TCC of the upper urinary tract has three general CT appearances: a focal intraluminal mass, urothelial wall thickening, and an infiltrating mass enhances after administration of IV contrast material. [37]

Wilms:

Wilms tumor (nephroblastoma) accounts for 87% of pediatric renal masses and occurs in approximately 1:10,000 persons. Its peak incidence is at 3–4 years of age, and 80% of patients present before 5 years of age. Wilms tumor is bilateral in 4%–13% of children. [18]. On unenhanced CT scans, Wilms tumor characteristically appears as a large (mean diameter 11 cm), spherical, at least partially intrarenal mass, and can cross midline and cause displacement of the vessels rather than encasement.

Following contrast administration, the tumor enhances less than the surrounding normal parenchyma. Most tumors (approximately 80% of cases) are heterogeneous with low-attenuation areas representing necrosis, hemorrhage, or cystic degeneration. Calcification seen in 10%. [14,38.] With Wilms tumor, it is crucial that the inferior vena cava be evaluated, as the tumor often grows directly into the renal veins, the inferior vena cava, and occasionally the heart., seen in 4% of patients. [16,39]

Preferred locations for metastases are the locoregional lymph nodes and the lung. Liver metastases are possible. Other distant metastases, e.g. in the skeletal system, are rare. [40]

Aim of the study: To evaluate the accuracy of computed tomography in preoperative assessment of solid renal tumor concerning types, extension and staging on basis of radiological features of the tumor.

PATIENT AND METHOD

Patients: This is a prospective study conducted upon 55 patients whose age range from 6 months to 81 yr with mean of age 51.6 yr. The examinations were done in hospitals of Erbil Teaching Center in department of radiology. The period was between December 2010 to January 2012. the patients were referred to CT unit for evaluation of a known case of solid renal mass discovered by previous CT or other imaging modality mostly from US (we excluded cystic mass either simple or complicated). In this study 51 cases underwent partial, total nephrectomy or FNAC and the diagnosis and staging was established on the basis of surgical and pathological finding. While 3 cases were diagnosed as AML by noticing fat density within the masses and showed no complications. Two experienced radiologist reviewed the CT studies in an independent fashion.

Methods: CT scans were obtained by Somatom emotion unit (Siemens,Germany) , single – slice spiral scanner spiral scanner, 120-130 KV and 90 mAs.

Patient was fasting for 6 hrs, in lying supine position and axial section with slice thickness (8 mm) and in case of small lesions we were used 5 mm. In all pt CT scan was done before and after IV contrast (unenhanced phase is required for fat, calcification and hemorrhage detection), the intravenous injection was low – osmolar, non – ionic contrast medium that was administrated manually (50 – 100 ml of Iohexol 350 mg/ml) and scanning start after 50 secs for parenchymal phase which is better for tumor assessment and delay after 10 minute for collecting system analysis. Using 20 HU as cutoff point for evaluation of enhancement state. About oral contrast (30 cc of gastrografin in 1 liters of water administrated orally 2 hours prior to scanning) was used. The characteristics of the masses on images were recorded for each examination. The size (the size was defined as the maximum diameter measured and in case of irregular shaped tumor the largest measurement was recorded), density, degree of enhancement, extension, and lymph node and venous involvement, all evaluated in axial and multi planar reconstruction.

RESULTS

Sex and age distribution (Table 2) :In this study of 55 cases with mean age 51.6 yr. 33 (60%) were male with mean age 50.3 yr and 22 (40%) were female with mean age 52.5 yr and male to female ratio 1.5:1 (Table 3). In this study 5 cases were below 10 yr (were diagnosed as 4 wilm's and 1 lymphoma). 1 case was RCC in 22 yr old with (Von Hippel-Lindau), while the other were above 35 years old.

Table 2: gender distribution by age groups

Sex	No	%
Male	33	60
Female	22	40
Total	55	100

Table 3: frequency distribution of the study sample by sex

Groups of age	Gender				Total no	Total %
	Male		Female			
	No	%	No	%		
0-9	2	3.6	2	3.6	4	7.2
10-19	0	0	1	1.8	1	1.8
20-29	1	1.8	0	0	1	1.8
30-39	1	1.8	2	3.6	3	5.5
40-49	2	3.6	2	3.6	4	7.2
50-59	13	23.6	6	11	19	34.5
60-69	10	18.1	6	11	16	29.1
70-	4	7.2	3	5.5	7	12.7
Total	33	60	22	40	55	100

Size:
In this study the size was between 1.5 – 11 cm, mean 4.8 cm. The smaller one was AML and the larger one was Wilms tumor.

Site and side distribution (Table 4):
In the current study 50 (90.9%) tumors raised from the renal parenchyma and 2 (TCC) from collecting system while 3 were diffuse (1 was lymphoma and 2 cases were RCC), 30 (54.5%) cases were located in the right kidney and 25cases in the left kidney (45.5%) with right to left ratio was 1.2:1 **(Figure 1).**

Table 4: frequency distribution of the study sample by side

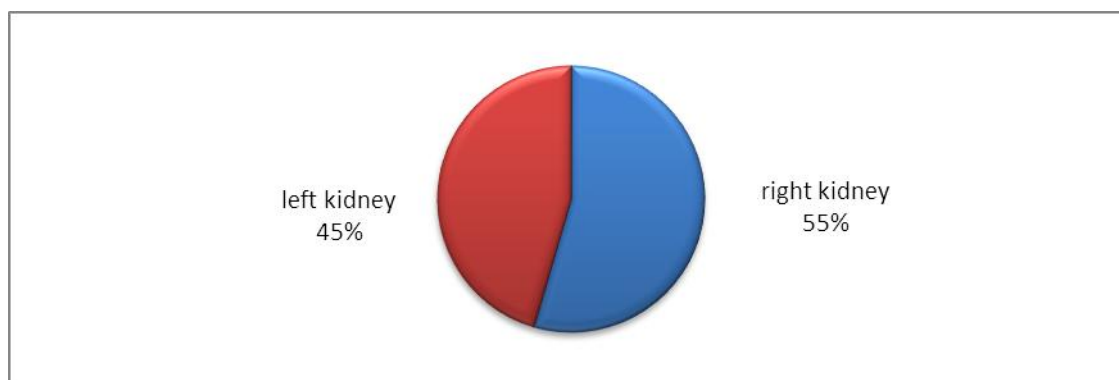| Affected side	No	%
Right	30	54.5
Left	25	45.5
Total	55	100

Figure 1: pie chart shows frequency distribution of the study sample by side.

Final diagnosis (benign and malignant lesions) (Table 5):

About 55 cases 49 (89%) were malignant and 6 (11%) were benign lesion.
Out of malignant lesions 40 (72.7%) were RCC which was the commonest type of malignant lesions, 2 (3.6) TCC , 2 (3.6%) lymphoma, 1 (1.8%) metastases and 4 (7.2%) Wilms tumor **(Figure 2)**.

Out of 4 cases with Wilms tumor 1 case was in 10 yr while other between 2 -5 yr tumor (**Figure 3**). The sex distribution 2 were in male and 2 were in female, the mean size was 6.6 cm with range of 4.5-11cm. all were heterogeneous in attenuation and 1 case was show calcification,

Regarding lymphoma 2 cases were seen, the first in a 6 m was presented as diffuse bilateral lesion diagnosed as primary non Hodgkin. The second case presented as multiple masses in a 59 yr and diagnosed as 2ry NHL.

Regarding 2 cases of TCC 1 was seen in a 66 yr old female which showed single lymph node involvement and the second was in a 81 yr old male was confined to the collecting system **(Figure 4).**

Regarding adenocarcinoma metastases proved by histopathology was seen in 1 case in male as single mass measured 4.5 cm with no history of primary and CT diagnosis was RCC.

About benign masses the final diagnosis were as following. 5 cases were AML 3 were in female and 2 were in male 2 underwent surgery with size more than 4 cm and 3 cases less than 3 cm were diagnosed by detection of fat in CT **(Figure 5).**

1 case was oncocytoma measuring 5 cm seen in a 62 yr old male it was located in the upper pole of the right kidney and shows the typical central scar **(Figure 6)**.

Table 5: Frequency distribution of the renal tumor by final diagnosis

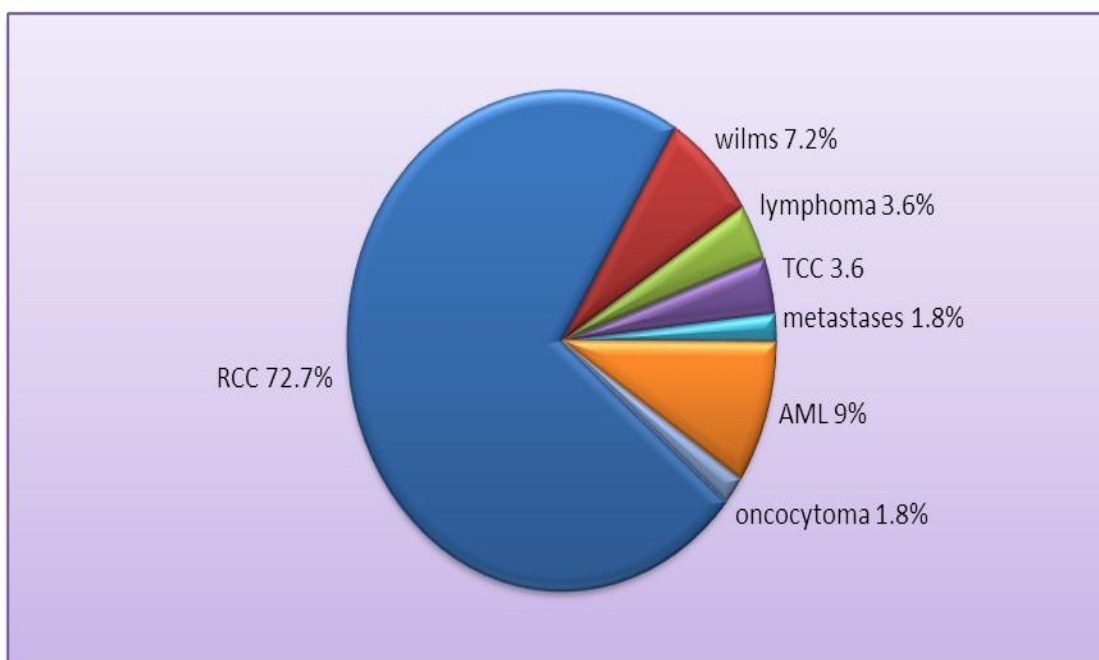| Types of the tumor		Male		Female		Total	
		No	%	No	%	No	%
Malignant	RCC	26	47.2	14	25.5	40	72.7
	TCC	1	1.8	1	1.8	2	3.6
	Wilms	2	3.6	2	3.6	4	7.2
	Lymphoma	1	1.8	1	1.8	2	3.6
	Metastases	1	1.8	0	0	1	1.8
Benign	AML	1	1.8	4	7.2	5	9.2
	Oncocytoma	1	1.8	0	0	1	1.8
Total		33	60	22	40	55	100

Figure 2: pie chart shows the distribution of solid renal tumor by final diagnosis

RCC: In our study we diagnosed 42 cases of RCC based on CT finding of which the final diagnosis based on histopathology , 40 were RCC, 1 metastases and 1oncocytoma.
So the sensitivity, specificity, accuracy, NPV, PPV in diagnosis of RCC were 100%, 86.6%, 96.3%, 100%, 95.2% respectively.

RCC and age: The percentage of RCC in this study by the age group shown in the **(Figure 3)** .The mean age (56.1yr) range (22–78yr).The highest percent was between50-59yr (16 cases (40%)).1 case was seen in 22 year old male with known case of Von Hipple-Lindau and the older one 78 years old male with history of contralateral side RCC underwent nephrectomy.
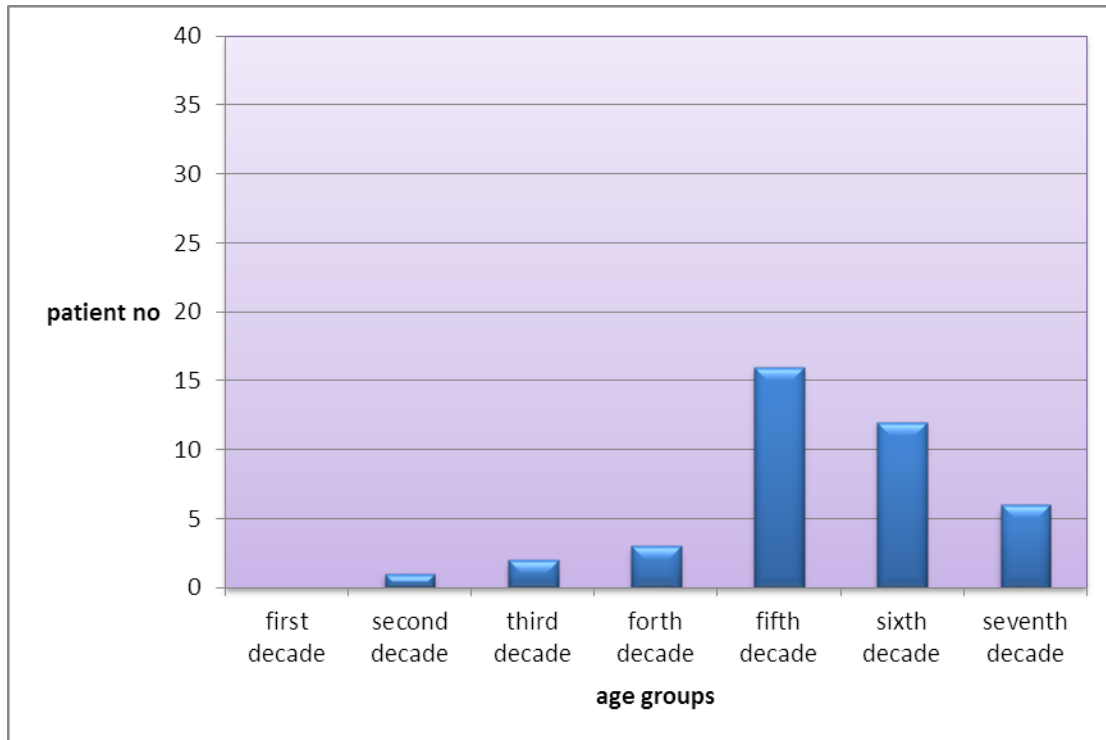
Figures 3: histogram of the frequency distribution of RCC by age groups

The side and site:

Regarding 40 cases of RCC 22 (55%) were involved the right kidney and 18 (45%) involved the left side with ratio 1.2:1, 16 (40%) were in lower pole 10 (25%) in upper and 12 (30%) in mid zone, our study showed 38 (95%) cases of RCC were focal masses of which 36 exophytic (90%) and 2 (5%) within the kidney out line, the other 2 (5%) were infiltrative which is rare finding in the renal cell carcinoma**(Table 6).**

Table 6: frequency distribution of RCC by side and site

1.Affected side	No	%
Right		
Left	22	55
	18	45
2.Affected site		
Lower zone	16	40
Upper zone	10	25
Mid zone	12	30
Diffuse	2	5

RCC and size:

In this current study of 40 cases of RCC the mean size (4.6 cm) and median size 5.5 cm with range between (2–9cm). the size above 5 cm usually show high stage either local extension or distant metastases as seen below.

RCC and gender:

Out of 40 cases with RCC 26 (65%) male and 14 (35%) female with male to female ratio 1.8:1 **(Figure 8)**
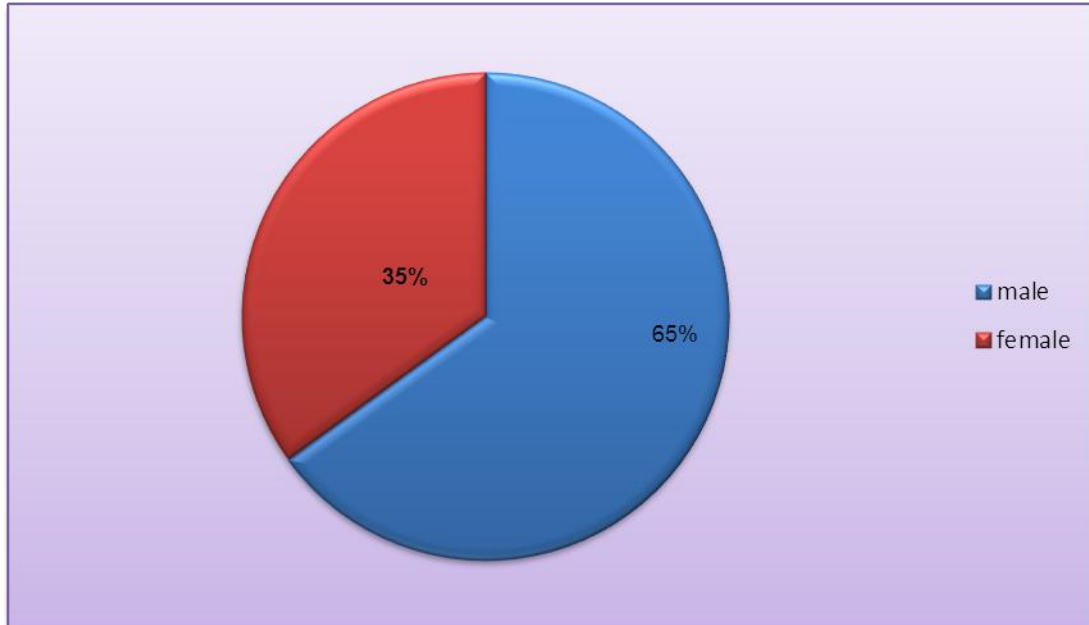
Figure 4: pie gram shows the frequency distribution of RCC by se

RCC and venous involvement:

9 (22.5%) cases of RCC were show venous involvement, 5 cases in the right renal vein, 4 in the left renal vein and 3 (7.5%) cases IVC extension of which all show renal vein involvement 2 with right vein and 1 with left renal vein. CT was diagnosed all cases of venous involvement correctly with accuracy 100%.

RCC and adjacent organ invasion:

In this current study the adrenal gland was involved in 6 cases (15%) 4 cases were in the right and 2 in the left. All were seen in case of large tumor and the adrenal gland cannot be visualized individually and looks continuous with the proper tumor.

The Gerota's fascia involvement were seen in 4 cases (10%) , 2 case were on the left and 2 on the right. The NPV for adjacent organs spread was 100% in this study.

RCC and perinephric invasion:

18 (45%) cases showed perinephric spread and 22 (55%) were localized to the kidney of which 14 (63.6%) were below 5 cm (T1), in this study 1 case was false negative due to microinvasion and 1 case was false positive due to inflammation , so the sensitivity, specificity, accuracy, NPV, PPV were 94.7%, 95.2%, 95%, 94.7%, 95.2% respectively.

RCC and Lymph nodes:

In this current study we depended on the size of 1 cm of the short axis as cutoff point for lymphadenopathy. 10 cases were diagnosed as lymphadenopathy based on CT of which the final diagnosis were 9 cases were show lymph nodes involvement and 1 case was hyperplasia, and False negative seen in 1 case with micro invasion . So the total number were 10 cases (25%) , 6 on the right and 4 on the left. So the CT sensitivity, specificity, accuracy, NPV, PPV were 90.9%, 96.5%, 95%, 96.5%, 90.9% respectively.

RCC and distant metastases:

Within the duration of our study 6 cases (15%) were presented with distant metastases, of which 4 cases were presented with liver metastases, 3 with lung and one with bone metastases to the vertebra. (2 cases show 2 site of metastases the 1st with liver and bone metastases and 2nd was liver and lung metastases).
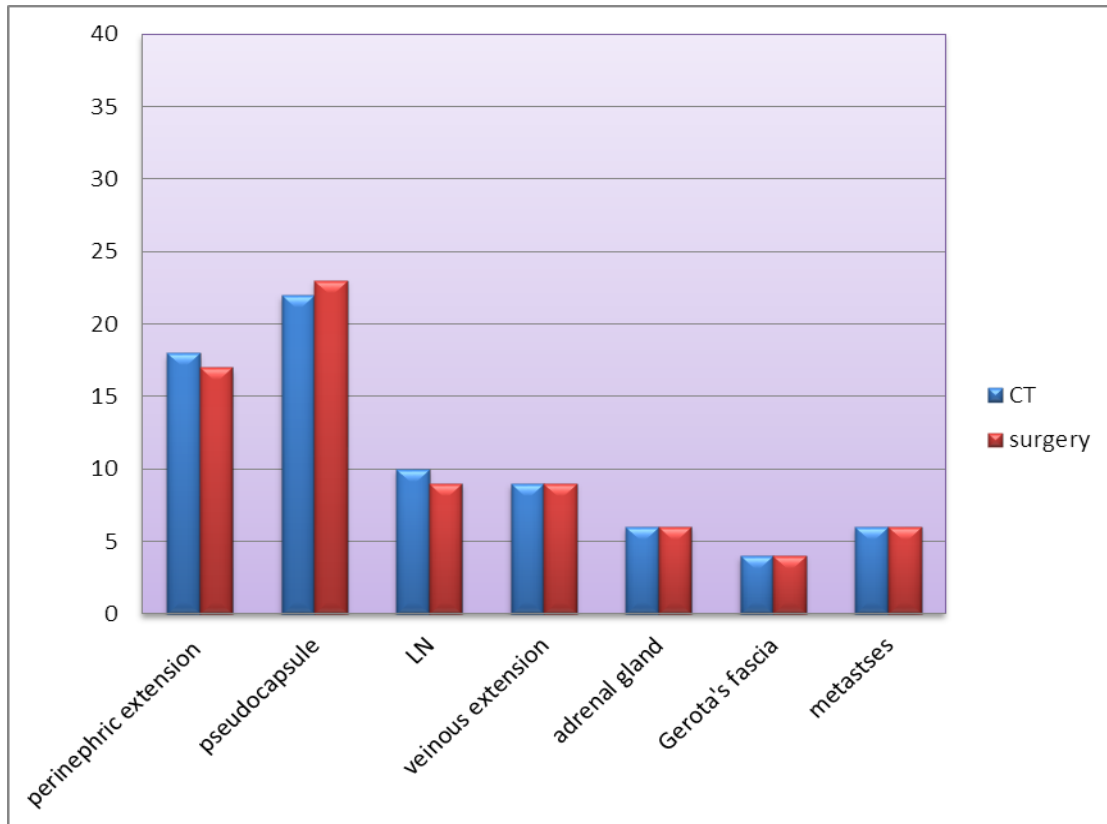
Figure 5: histogram shows results of CT and surgery

RCC and Radiological features (Table 8):

Out of 40 cases with RCC on unenhanced phase 20 (50%) were homogeneous of which 11 (72.5%) hypodense 9 (22.5%) isodense and 20 (50%) were hetrogeneous density, mean attenuation (39 HU) range 23 -55.

All showed enhancement post IV contrast with mean 108 HU enhancement range 24 - 220H , 9 (22.5%) homogeneous enhancement of which 6 (66.6%) were below 3 cm and 31 (77.5%) were heterogeneous. out of 40 cases 28 (70%) show enhancement less than renal cortex, 6 (15%) were iso and 6 (15%) were hyper than renal cortex.
Calcification was seen in 10 (25%) as amorphous or irregular pattern.

In this current study calcification was seen in 11 tumors, 10 were RCC and 1 was Wilms tumor).
Hemorrhage was seen in 2 cases (5%).

Table 8: CT features of RCC

	Radiological findings	**No**	**%**
Precontrast	**Homogeneous**	**20**	**50**
	Heterogeneous	**20**	**50**
	Isodense	**11**	**27.5**
	Hypodense	**9**	**22.5**
	Calcification	**10**	**25**
	Hemorrhage	**2**	**5**
Post contrast	**Homogeneous enhancement**	**9**	**22.5**
	Heterogeneous enhancement	**31**	**77.5**

DISCUSSION

CT plays a central role in the evaluation of a patient with renal tumor. This study shows CT was an accurate in the preoperative evaluation and staging of the solid renal tumor. This study showed among all solid renal tumor 89% were malignant and 11% benign although this is high percentage but in population the malignant tumor is still more than benign lesion and it is comparable to Zhang et al [41] and Lechevallier et al [42]. Regarding final diagnosis RCC 40 (72.7%) which was identical to Walter et al [43] but higher than Basim[12] because the study has included non neoplastic and cystic masses and less than Zhang et al [41] where RCC formed 80% of solid renal tumor. 2 cases were TCC (3.6%), 2 (3.6%) lymphoma, 4 (7.2%) Wilms and 1 (1.8%) was metastases (adenocarcinoma metastases) which is consistent with Zhang et al [41] and Lechevallier et al [42].

In our study the analysis of the solid tumor regarding age in 55 cases ranged between 6m - 81 yr with mean age 51.6 yr and median 58 yr. Regarding gender 33 (60%) were male with mean age 50.3 yr and 22 (40%) were female with mean age 52.5 yr, male to female ratio 1.5:1. This result was consistent with that of Zhang et al [41] .In this current study the largest tumor seen measured 11 cm in its largest measurement and diagnosed as Wilms, while the smallest mass measured 1.5 cm and diagnosed as AML, the range was 4.8 cm. this result goes well with study was done by Basim[12] and Lechevallier et al [42]. Among all solid renal tumors in this study 50 cases were focal and arise from the renal parenchymal (90.9%), 2 from collecting system (3.6%) were TCC and 3 were diffuse 5.5% (1 lymphoma and 2 RCC).

Regarding side (54.5%) of lesions were seen in right kidney and 45.5% were in left kidney, this result is consistent with that stated by Zhang et al [41].

Renal Cell Carcinoma (RCC):

RCC and size: In this study the mean size and median size were 4.6 and 5.5 cm respectively with range between 2-9 cm and this results were near to results of a study made by Brookman et al [44] and Catalano. et al [45]. It is so obvious the relation between the size and aggressive behavior of the tumor.

Age and gender distribution: Regarding RCC the mean age were 56.1 yr range 22-78yr the highest percent in 50 decade with male to female ratio 1.8:1 which is comparable to results by Basim[12], Catalano. et al [45], Davidson et al [46] and Ruppert et al [47]

RCC and location: Regarding the site and the side distribution about 16 (40%) seen in the lower pole, 10 (25%) upper and 12 (30%) mid part which is comparable to prior study Atwell et al [48] and Basim[12]. In this study out of 40 cases of RCC were more in right 22 (55%) than in left 18 (45%) with ratio 1.8:1 same results by studies Atwell et al [48] and also consistent with that stated by Basim[12] and Zhang et al [41], while our results not consistent with that stated by Davidson et al [46] which show that 52.4% on the left. although there is no significant in difference in the side.

Our study was showed 38 (95%) cases of RCC were focal masses of which 36 exophytic (90%) and 2 (5%) within the kidney out line, the other 2 (5%) were infiltrative which is rare finding in the renal cell carcinoma. These goes well with the results stated by Gervais et al [49] .

RCC and radiological features: Some radiological features are important in determining the nature of the tumor and the aggressive behavior like necrosis, calcification, extension and enhancement. In this study considering 40 cases of RCC on unenhanced CT with mean attenuation 35 HU, 20 masses (50%) were homogeneous (11 hypodense (27.5%) and 9 (22.5%) isodense) and 20 (50%) were heterogeneous. Post IV contrast all tumor showed enhancement with mean range 108 HU, majority showed heterogeneous enhancement 31 (77.5 %) and 28 (70%) were enhanced less than renal cortex. This result is consistent with that results by Graser et al [50], and also with that of Zhang et al [41] and Ruppert et al [47].

About calcification of 55 cases were noted in 11 tumor (20%) 10 25% were RCC in one case in wilm's, so calcification mostly seen in malignant tumor consistent with study of and DanielWWet al [51] and Zagoria et al [52].

RCC and TNM staging: The goals of radiologic imaging are to detect and stage the 1ry tumor and the CT is considered the main technique. Treatment of RCC is based on tumor stage which depend on tumor size, extent and venous involvement.

Regarding staging 16 (40%) were T1, 4 (10%) T2, 16 (40%) T3, and 4 (10%) T4, comparable to what is reported by Hsu et al [53] and not consistent with that reported by Zhang et al [54] which show T1 was 81%, T2 6% and T3 13% mostly because

the last study was dealing with smaller tumor with mean size 2.3 cm. This show increase percentage of early stages mostly due to increase incidentally tumor detected by imaging technique mostly Ultra Sound.

RCC and venous involvement: Out of 40 cases of RCC 9 cases (22.5%) were show renal and caval venous involvement, 5 on the right and 4 on the left, of this 3 cases (7.5%) were show IVC extension all were infrahepatic. These result s are similar to that estimated by Catalano et al [45] and Zeman et al [55].

Assessment of the venous system is essential because it is very important in treatment planning and CT is an effective method for identify and localized the extent of the tumor thrombus in all patient Welch et al[56]

RCC and perinephric invasion: This study shows that 55% were localized to the kidney with 63.3% were below 5 cm (T1), out of the 40 cases 18 cases were diagnosed with perinephric invasion based on CT, the final diagnoses were 18 cases with invasion , 1 case was false positive due to inflammatory reaction and 1 case was false negative due to micro invasion and no image criteria exist to diagnose such invasion.

The sensitivity in extra renal extension was 94.7%, specificity 95.2% and accuracy was 95%. The NPV and PPV were 94.7% and 95.2% respectively. This data is comparable with that of Catalano et al [45] and Hsu et al [53].
The perinephric invasion with lymph node assessment are considered most of the CT limitation in this and other studies which can lead to over or under staging.

RCC and adjacent organs: The most common organ to be involved is adrenal gland. In our study 6 (15%) of RCC show suprarenal gland involvement with 100% NPV. This is nearly going with that reported by Catalano et al[45].

Evaluation of suprarenal gland is useful in adrenal sparing nephrectomy to reduce the risk of future adrenal insufficiency. Involvement of the Gerota's fascia were seen in 4 cases (10%) all were in mass more than 5 cm and 3 of them associated with adrenal gland extension. CT can detect spread of the tumor outside Gerota's fascia with high efficacy with NPV 100% in this study.

RCC and lymph nodes: In this current study 10 cases were diagnosed as lymphadenopathy with 1 case false positive (2.5%) which showed hyperplasia and 1 case false negative (2.5%) due to micro invasion. 6 were on the right and 4 in the left. This is mostly because the principle of assessment the lymph nodes in CT depend on the size with 10 mm as cutoff value.

So the CT sensitivity, specificity, accuracy, NPV, PPV in lymph nodes assessment were 90.9%, 96.5%, 95%, 96.5%, 90.9% respectively. This results is consistent with that of Catalano et al [45] and Basim[12].

Distant metastases: This study shows 6 cases (15%) of the patients with RCC show metastases 4 cases with liver metastases , 3 lung metastases and one to the bone, this results are similar to that stated by Catalano et al [45]. CT is very accurate in detecting and screening for metastases to determine the treatment planning.

Other malignant lesions: In our study other malignant masses were diagnosed as following which is comparable with Basim[12] :

1. 4 cases were Wilm's tumor , 3 were aged between 2-5 yr old and 1 case was at 10 yr old. 2 cases were in males and 2 were in females. The mean size was 6.6 cm range between 4.5-11 cm. all were heterogeneous and one case was show calcification.
2. 2 cases were lymphoma, the 1st one was 1ry NHL which is very rare in the kidney and the 2nd was presented as multiple masses in the kidney which was 2ry NHL.
3. Regarding TCC 2 cases were diagnosed 1 was in female which showed regional lymph node involvement and 1 in male was localized to PCS and follow up of both cases is advised for extra renal TCC.

Benign mass: This is considered limitation of this study due to small number of benign mass.

1. Six cases (11%) of our study were benign masses 5 AML, 2 cases underwent surgery due to large size and complications. All cases were diagnosed by detecting fat within the mass and this consider diagnostic criteria.
2. One case was Oncocytoma (1.8%) seen in 62 yr old male in the right side measured 5 cm and show enhancement and central scar which develop in 30-50% of Oncocytoma according the text books.

CONCLUSION

1. CT remains an established tool in diagnosis and characterization in any patient with renal mass because it is fast, available, non invasive, non operator dependent and shows excellent anatomical details.
2. CT is the most frequently used technique for staging and preoperative assessment of solid renal tumor with some limitation mostly in the perirenal invasion and lymph nodes involvement. But show high accuracy in venous extension and direct or distant metastases.
3. TNM staging is now the most widely used for staging which is important in treatment and reflect the survival.
4. Renal cell carcinoma is the commonest cause of solid renal mass.
5. The contrast medium should be injected dynamically instead of manual injection to increase the sensitivity of lesion detection.

REFERENCES

[1] Lee, Joseph K. T.; Sagel, Stuart S.; Stanley, Robert J.; Heiken, Jay P.   Computed Body Tomography with MRI Correlation. 4th Edition . Lippincott: Williams & Wilkins; 2006. P.1233-1237:1258-1264
[2] Brant, William E.; Helms, Clyde A.Fundamentals of Diagnostic Radiology. 3rd Edition. Lippincott Williams & Wilkins; 2007.
[3] Wein Alan J, Kavoussi Louis R, NovickAndrewC, Partin Alan W, Peter Craig A, Cambell-Walsh Urology. ninth edition. Saunders, An imprint of Elsevier. 2007.
[4] Haaga. John R, Dogra. Vikram S, Forsting. Michael, Gilkeson. Robert C, Hyun Kwon Ha, Murali Sundaram. CT and MRI of the Whole Body. Fifth edition, 2009, Mosby . Chapter 41 – Kidney
[5] Kpala. Julian. The kidney and ureter. In: David Sutton. Textbook of Radiology and Imaging. 7th edition London;2003. p. 949-962.
[6] Guermazi. Ali. Imaging Of Kidney Cancer. Springer. Springer-Verlag Berlin Heidelberg 2006
[7] Butler. Paul, Mitchell. Adam W. M, Ellis. Harold. Applied Radiological Anatomy for Medical Students. 2007. Cambridge university, New York. chapter 6; P 47-49.
[8] Morcos. Sameh K, Cohan. Richard H. New Techniques in Uroradiology 2006 by Taylor & Francis Group, LLC.
[9] Siroky. Mike B, Edelstein. Robert A, Krane. Robert J. Manual of Urology: Diagnosis and Therapy 2nd edition:1998 Lippincott, Williams & Wilkins
[10] Stuart G. Silverman, Richard H. Cohan. CT Urography: An Atlas, 1st Edition. 2007. Lippincott Williams & Wilkins
[11] Gillenwater. Jay Y, Grayhack. John T, Howards. Stuart S, Mitchell. Michael E. Adult and Pediatric Urology. 4th edition. 2002. Lippincott Williams & Wilkins.
[12] Basim. Sahar. Value of computed tomography in renal mass. Iraqi Board Thesis , Baghdad 2005.
[13] Tanagho. Emil A, McAninc. Jack W. Smith's General Urology . he McGraw-Hill Companies 2008 Seventeenth Edition
[14] Dahnert, Wolfgang. radiology review manual 6th edition chapter 10. Urogenetal tract, 2007. Lippincott Williams & Wilkins, p922-980.
[15] Israel. Gary M, Bosniak. Morton A. How I Do It: Evaluating Renal Masses. Radiology 2005; 236:441–450
[16] Grainger RG, Allison DJ , Adam A, Dixon AK, eds.(2008).Grainger & Allison's Diagnostic Radiology: A Textbook of medical imaging . 5th edition Churchill Livingstone , London .
[17] Gunderman. Richard B. Essential Radiology Clinical Presentation • Pathophysiology • Imaging Second Edition. 2006. Thieme Medical Publisher chapter 5.
[18] Lisa H, et al Pediatric Renal Masses: Wilms Tumor and Beyond . Radio Graphics 2000; 20:1585–1603
[19] Prasad. Srinivasa R, Humphrey. Peter A, Catena. JayR, Narra. Vamsi R. Srigley. John R. Cortez. Arthur D et al. Common and Uncommon Histologic Subtypes of Renal Cell Carcinoma: Imaging Spectrum with Pathologic Correlation. Radio Graphics 2006; 26:1795–1810 November-December 2006
[20] Vikram. Raghunandan, Caan S. Ng, Tamboli. Pheroze, Tannir. Nizar M, Fonasch. Eric, Matin. Surena F Et al Papillary Renal Cell Carcinoma: Radiologic-Pathologic Correlation and Spectrum of Disease. Radio Graphics 2009; 29:741–757. RSNA, 2009 • radiographics.rsnajnls.org
[21] Macfarlane, Michael T. Urology, 4th Edition 2006 Lippincott Williams & Wilkins
[22] weissleder. Ralph, wittenberg. Jack, harisinghani. Mukesh G.   Primer of diagnostic imaging .Third Edition Copyright O 2007, Mosby, Inc. ch 4
[23] Schrier . Robert W. Diseases of the Kidney and Urinary Tract 7th edition 2001 Lippincott Williams & Wilkins
[24] Ambos. Marjorie A, Bosniak. Morton A, Madayag. Manuel A, Lefleur. Richard S. infiltrating Neoplasms of the Kidney. Am J Ro.ntgenol 129:859-864, November 1977
[25] Palmer. William E, Chew. Felix S. renal oncocytoma. AJR 156:1144, June 1991
[26] Urban. Bruce A, Fishman. Elliot K.   renal lymphoma :CT patterns with emphasis on helical CT Radiographics Jan-feb 2000; 20: 197-212
[27] Sheeran. Sean R, Sussman. Steven K. Renal Lymphoma: Spectrum of CT Findings and Potentia Mimics. AJR 1998 :171:1067-1072, October1998
[28] Chepuri. Neeraj B, Strouse. Peter J, Yanik. Gregory A. CT of Renal Lymphoma in Children. AJR 2003;180:429–431. American Roentgen Ray Society,
[29] Prasad. Srinivasa R, Dalrymple. Neal C, Surabhi. Venkateswar R. Cross-sectional Imaging Evaluation of Renal Masses. Kalra. Mannudeep K, Blake. Michael A. Radilogical clinics of north 2008. Eleseviersaunders.

[30] Durand. Xavier, Renard-Penna. Raphaelle, Comperat. Eva, Bitker. Marc-Olivier, Richard. Francois. Renal Angiomyolipoma Associated with Inferior Vena Cava Thrombus . 2009 Xavier Durand et al . Article ID 789078

[31] M Muttarak, Pattamapaspong, B Lojanapiwat, B Chaiwun. Renal angiomyolipoma with bleeding. 2007 http://www.biij.org

[32] Federle. Michael R et al Diagnostic imaging abdomen.2004. first edithion. Part III section 3 p96.

[33] Helenon. Olivier, Merran. Samuel, Paraf. Francois, Melki. Philippe,Correas. Jean M, Chretien. Yves et al.   Unusual Fat-containing Tumors of the Kidney: A Diagnostic Dilemma. RadioGraphics 1997; 17 :129-144

[34] Honda. H, Coffm.E, Berbaum. S, Barlo. J, Masud. K. CT Analysis of Metastatic Neoplasms Of The Kidney. Comparison with primary renal cell carcinoma. ActaRadiologica 33 (1992).

[35] Prando. Adilson, Prando. Patricia, Prando. Decio. Urothelial cancer of renal pelvicaliceal system: unusual imaging manifestations. RadioGraphics. 30;1553-1566

[36] Vikram. Raghunandan, Sandler. Carl M, Ng. Chaan S. Imaging and Staging of Transitional Cell Carcinoma: Part 2, Upper Urinary Tract.2009 AJR 2009; 192:1488–1493

[37] Kawamoto. Satomi, Horton. Karen M, Fishman. Elliot K. Transitional Cell Neoplasm of the Upper Urinary Tract: Evaluation with MDCT. AJR 2008; 191:416–422

[38] Marilyn J. Siegel. Pediatric Body CT, 2nd Edition. 2008 Lippincott Williams & Wilkins chapter 9; p297

[39] Haller. Jack O, Slovis. Thomas L, Joshi. Aparna. Pediatric Radiology 3rd Edition. 2004. P164 chapt.6

[40] Tröger. Jochen, Seidensticker. Peter. Paediatric Imaging Manual. 2008. springer. P97. Ch 5

[41] Zhang. Jingbo, Lefkowitz. Robert A, Ishill. Nicole M, Wang. Liang, Moskowitz. Chaya S, Russo. Paul et al. Solid Renal Cortical Tumors: Differentiation with CT. Radiology 2007; 244:494–504.

[42] Lechevallier. Eric, Andr. Marc, Barriol. David, Daniel. Laurent, Eghazarian. Christophe, Fromont. Marc De et al . Fine-Needle Percutaneous Biopsy of Renal Masses with Helical CT Guidance. Radiology 2000; 216:506–510. RSNA.

[43] Walter. C, Kruessell M, Gindele A, Brochhagen H G, Gossmann A, Landerwehr. P. Imaging of renal lesions: evaluation of fast MRI and helical CT. The British Journal of Radiology, 76 (2003), 696–703 E 2003 The British Institute of Radiology.

[44] Brookman-May. Sabine, Johanssen. Manfred, May. Matthias, Hoschke. Bernd, Gunschera. Jana, Wieland. Wolf F et al. Difference Between Clinical and Pathologic Renal Correlation With Survival, and Implications for Patient Counseling Regarding Nephron-Sparing Surgery. AJR 2011; 197 (5) :1137-1145

[45] Catalano. C, Fraioli.F, Laghi. A, Napoli. A, Pediconi. F, Danti. M. et al. High-Resolution Multidetector CT in the Preoperative Evaluation of Patients with Renal Cell Carcinoma. AJR 2003;180: 1271–1277.

[46] Davidson. Alan J, Hayes. Wendelin S, Hartman. David S, McCarthy. William F, Davis. Charles J. Renal Oncocytoma and Carcinoma:Failure of Differentiation with CT. RSNA, Radiology 1993; 186:693-696

[47] Ruppert-Kohlmayr. Andrea J, Uggowitzer. Martin, Meissnitzer. Thomas, Ruppert. Georg. Differentiation of Renal Clear Cell Carcinoma and Renal Papillary Carcinoma Using Quantitative CT Enhancement Parameters. AJR 2004;183: 1387–1391.

[48] Atwell. Thomas D, Farrell. Michael A, Callstrom. Matthew R, Charboneau. J William, Leibovich. Bradley C, Patterson. David E et al. Percutaneous Cryoablation of 40 Solid Renal Tumors with US Guidance and CT Monitoring. Radiology:2003; 243: 276-283.

[49] Gervais. Debra A, McGovern. Francis J, Arellano. Ronald S, McDougal. W. Scott, Mueller. Peter R. Renal Cell Carcinoma: Clinica Experience and Technical Success with Radio-frequency Ablation of 42 Tumors. Radiology 2003; 226:417–424.

[50] Graser. Anno, Johnson. Thorsten RC, Hecht. Elizabeth M, Becker. Christoph R, Leidecker. Christianne, Staehler. Michael et al. Dual-Energy CT in Patients Suspected of Having Renal Masses: Can Virtual Nonenhanced Images Replace True Nonenhanced Images?. Radiology: 2009; 252: 433-440.

[51] DanielWW, Hartman GW, Witten DM, Farrow GM, Kelalis PP. Calcified renal mass: areview of ten years experience at the Mayo Clinic. Radiology 1972; 103: 503–508.

[52] Zagoria et al. CT Features of Renal Cell Carcinoma with Emphasis on Relation to Tumor Size. Investigative Radiology. 25(3):261-266, March 1990.

[53] Hsu. Raymond M, Chan. David Y, Siegelman. Stanley S. Small Renal Cell Carcinomas: Correlation of Size with Tumor Stage, Nuclear Grade, and Histologic Subtype. AJR 2004; 182: 551–557.

[54] Zhang. Jingbo, Kang. Stella K, Wang. Liang, Touijer. Abdelkarim, Hricak. Hedvig et al. Distribution of Renal Tumor Growth Rates Determined by Using Serial Volumetric CT Measurements. Radiology 2009; 250:137–144.

[55] Zeman. Robert K. Renal Cell Carcinoma: Dynamic Thin-Section CT Assessment of Vascular Invasion and Tumor Vascularity. Radiology 1988; 167:393-396.

[56] Welch TJ, LeRoy AJ. Helical and electron beam CT scanning in the evaluation of renal vein involvement in patients with renal cell carcinoma. J Comput Assist Tomogr 1997; 21:467–471.

[57] Kidney. In: Edge SB, Byrd DR, Compton CC, et al., eds.: AJCC Cancer Staging Manual. 7th ed. New York, NY: Springer, 2010, pp 479-89.