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CORRELATION BETWEEN CONTRAST ENHANCED ABDOMINAL COMPUTERIZED TOMOGRAPHY SCAN AND HISTOPATHOLOGY IN EVALUATION OF RENAL MASSES

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Abstract

Renal tumors are divided into benign and malignant. The most common malignant renal tumor is renal cell carcinoma (RCC) with a rising incidence of about 3% per year since 1975, RCC accounts for nearly 3% of all solid tumors in the body and 65% of all renal tumors.

According to contrast enhancing computerized tomography (CECT), The enhancing masses are classified as solid or complex cystic, 85% percent of solid masses are malignant. Contrast medium rapidly redistributes from the vascular to the interstitial spaces of the organs, the more vascular the organ or pathologic mass the more enhanced one. Therefore, a solid, enhancing mass must be considered malignant until proved otherwise.

The aim of this study is to evaluate the role of contrast enhanced CT scan in the assessment of renal masses and its correlation with the histopathological type.

Over a period of eight months (from February 2013 to September 2013) 45 patients presented with renal masses (diagnosed by ultrasound) submitted to abdominal CECT scan, then the renal masses radiologicaly evaluated in the form of site, size, degree and pattern of enhancement, then the radiological findings were correlated with the postoperative specimen histopathological results.

Different histopathological types of renal tumors have different degree and patterns of enhancement. Regarding the degree of enhancement: The enhancement in Hounsfield units in order of frequency are as follows: Conventional renal cell carcinoma (Clear cell carcinoma) (27HU). Chromophobe renal cell carcinoma (19 HU). Onchocytoma (18.5 HU). Wilms (16.66HU). Transitional cell carcinoma (9.75 HU). Angiomyolipoma (5.33 HU).

According to the homogeneity of enhancement: There is difference between type of tumors and homogeneity of enhancement, as follows: Conventional renal cell carcinoma (clear cell carcinoma) have heterogeneous in 75% and homogenous in 25% of tumors. Chromophobe renal cell carcinoma, 50% have homogenous, while other 50% have heterogeneous pattern. Oncocytomas and Transitional cell carcinoma have 100% homogenous enhancement. Wilms tumors have 100% heterogeneous patterns. Angiomyolipomas have homogenous pattern in 66.7 % while heterogeneous enhancement seen in 33.3 %.

In conclusion, contrast enhanced CT Scan is highly valuable in differentiating types of renal masses in correlation with histopathological results.

Introduction

Renal masses can be divided into cystic and solid lesions[1]. The most common are cysts in up to 27% of patients over 50 years[2]. Computed Tomography (CT), or Magnetic Resonance Imaging (MRI)-enhancing masses are classified as solid or complex cystic. 85% of expansive solid masses are malignant. Therefore, a solid enhancing mass should be considered malignant unless proven otherwise. Renal Cell Carcinoma (RCC) is the most common malignant tumor with a rising incidence of about 3% per year since 1975. Renal cell carcinoma (RCC) accounts for nearly 3% of all solid tumors. It is estimated that approximately 46,000

new cases of RCC were diagnosed in 2008[3,4].

The most common subtype of RCC is the Clear Cell RCC (synonym: common or conventional RCC) with 65% of renal cortical tumors. Further subtypes are papillary (basophilic and eosinophilic) and chromophobe RCCs with about 25% of renal cortical tumors4. Clear-cell RCC causes 90% of metastases of all renal malignancies[5,6].

Other malignant masses include transitional cell carcinoma (TCC), lymphoma (primary and more frequent secondary), metastases from carcinoma and primary/secondary sarcoma. Primary tumors of the lung, breast and gastrointestinal tract are the most common sources of renal metastases[7].

Benign tumors account for approximately 20% of all solid renal cortical tumors, and renal oncocytoma is the most common solid tumors type[8,9].

The great majority of renal masses are found incidentally as a result of the use of computed tomography (CT), ultrasonography (US), and magnetic resonance (MR) imaging[10,11].

Fortunately, most of these are simple renal cysts that can be easily diagnosed and do not require treatment. However, solid and complex cystic renal masses are also discovered, many of which are clearly malignant and need to be surgically removed, while others may not require surgical intervention. Therefore, the proper characterization of these masses is essential so that appropriate management is instituted[12].

Approximately 10% of all renal cell carcinomas appear as complex cystic lesions on images. On the other hand, nonmalignant renal cysts can have a complex appearance, usually as a result of hemorrhage, infection, inflammation, or ischemia[13-17]. The Bosniak system for classification of renal cysts evolved over time, and on the basis of computed tomographic (CT) criteria, it has been largely accepted. Urologists and radiologists have used it as an effective tool in the characterization of cystic renal masses[18].

Role of CT in diagnosis of Renal masses:

Computed tomography (CT) is a rapid, easily performed 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[16].

CT appearance: (Figure (I):

The renal substance is homogeneous on plain CT images. MDCT is usually performed as a multistage study using thin slices. Precontrast scans are obtained from the kidneys through the bladder to detect urinary stones and calcifications. Arterial-phase scans through the kidneys show early enhancement of renal tumors. The renal cortex enhances before the renal medulla, resulting in the characteristic corticomedullary phase appearance also renal parenchymal enhancement is more than tumor enhancement. Because the medulla is unenhanced, small medullary lesions may be missed during this phase. At approximately 120 seconds following onset of contrast injection, the renal parenchyma is normally uniformly enhanced (the nephrogram phase scan). A pyelogram phase scan at 3 to 5 minutes shows contrast filling of the collecting system and ureters. MDCT allows acquisition of thin slices that may be reformatted into three-dimensional images of the collecting systems and ureters (Figure 1) mimicking an IVP but with the improved contrast resolution of CT. This type of study has been called a CT-IVP[17].

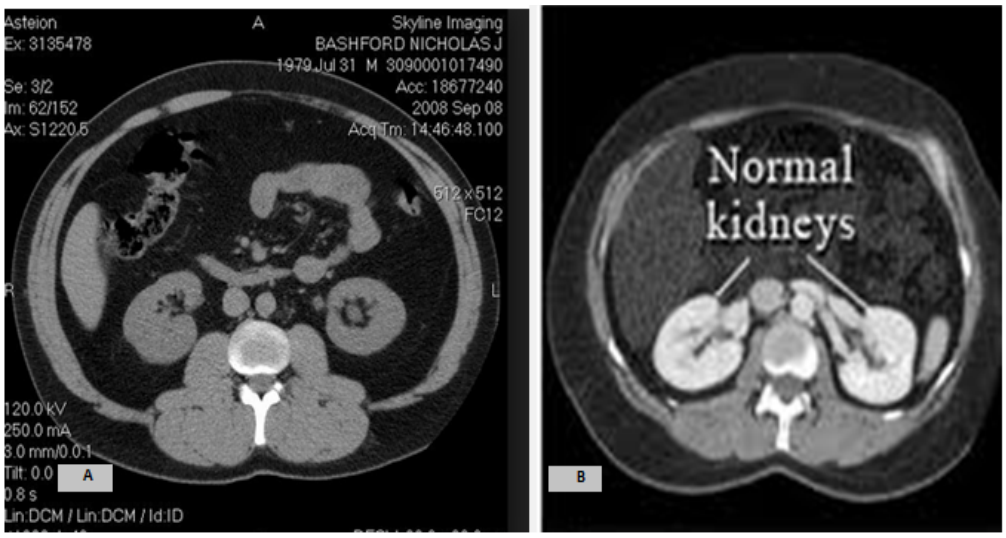


Figure 1: Normal CT anatomy. Unenhanced (A), with contrast (B)

This study aimed to evaluate the role of enhanced CT scan (arterial phase) in assessment of renal masses and its correlation with the histopathological type.

Patients and Methods

Over a period of eight months (from February 2013 to September 2013), 45 patients 25 males and 20 females with renal masses diagnosed by US, agreed to be submitted to abdominal CECT scan in AL-Najaf cardiovascular center at Al Sader Medical City. Patients' age range ia 3 to 70 years.

The inclusion criteria: patients with solid and complex renal masses.

The exclusion criteria: patients who have contraindication to CT scanning (like pregnant patient, renal failure and those who are allergic to contrast media), patients with simple renal cysts, polycystic kidneys, parapelvic cyst. Then the masses were radiologicaly evaluated for site, size, degree, pattern of enhancement, lymph node enlargement, venous extension or thrombosis (Infereior vena cava and renal veins) and metastasis. A correlation with the post operative specimen histopathological results was made.

CT Scanning Procedure: The study was performed using a 64-slice CT scanner (Aquillon 64, V4.51 ER010, Toshiba Medical Systems, Tochigi, Japan) of 120 kVp, variable tube current, and a slice thickness interval of (3 mm) starting with Precontrast scanning of abdominopelvic areas viewing on renal masses localizing its precise location and measuring the size and density of them by average cross and look for extra renal extension of the mass or distant metastasis.

Then a bolus of 50 to 100 milliliter (according to body weights 1ml /Kg body weight) of a non-ionic contrast medium (Omnipaque 350 mg/ml, GE Health care Ireland, Cork, Ireland) was administered via a 20-gauge intravenous cannula manually at a rate of (3-5 ml/s). And then rescanning at arterial phase (within 30 seconds of injection), measuring the post contrast density of the mass.

Results

Forty five patients presented with renal tumors diagnosed by US, 25 patients (55.56 %) males and 20 patients (44.44%) females who are submitted to abdominal CT scan with contrast enhancement in AL Najaf cardiovascular center at Al Sadar Medical City As shown in Figure 2.

Seventy percent of the patients were from urban areas while the others (30%) were from rural area as shown in Figure 3.

Patients' age ranged (3 to 70 years) with highest incidence around 50 years (14 patients (31.11%) as shown in Table I.

Renal cell carcinoma was the first most common, Wilms tumor was the second most common cause of solid renal masses seen in 6 patients (13.3%). Transitional cell carcinomas are the third causes of solid renal masses, while Angiomyolipoma and oncocytoma are the least two tumors accounting for 3 patients (6.66%), and 2 patients (4.44%) respectively, as shown in Table II.

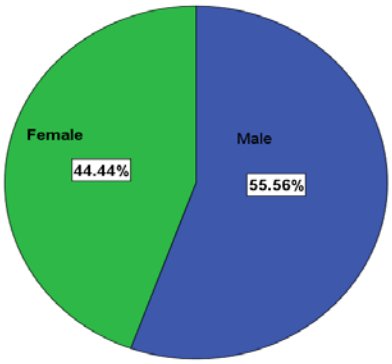


Figure 2: gender distribution of the patients.

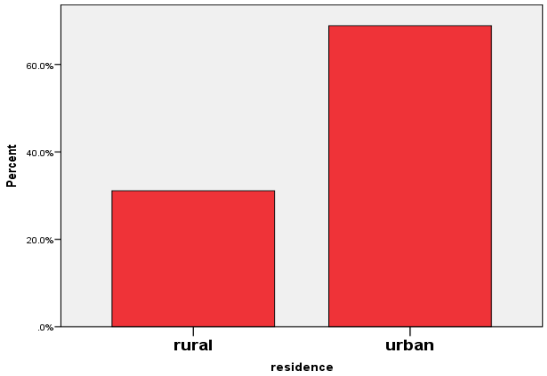


Figure 3: distribution of patients according to residence

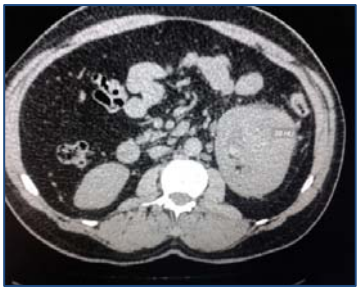
Table I: Age of patients in relation to type of tumor

Type of tumor	Numbers	Mean age (years)	Std. Deviation	P value
Clear cell carcinoma	28	54.4	10.00496	<0.001
Transitional cell carcinoma	4	50.5	11.73314	
Oncocytoma	2	52.0	4.24264	
Wilms tumor	6	4.5	1.37840	
Angiomyolipoma	3	47.3	17.21434	
RCC Chromophobe type	2	39.5	14.84924	
Total	45			

Table II: Number and percentage of different tumor types

Type of tumor	Number	Percentage
Renal cell carcinoma	30	66.66
Wilms tumor	6	13.3
Transitional cell carcinoma	4	8.88
Angiomyolipoma	3	6.66
Oncocytoma	2	4.44
Total	45	

The relation of degree of contrast enhancement and histopathologic type of renal tumors: Regarding enhancement in arterial phase the difference in Hounsfield unit (HU) in order of frequency are as follows: Clear cell carcinoma (27 HU), chromophobe cell carcinoma (19 HU), oncocytoma (18.5 HU), Wilms (16.7HU), transitional cell carcinoma (9.8 HU) and Angiomyolipoma (5.33HU), as shown in Figures4,5 and Table III.



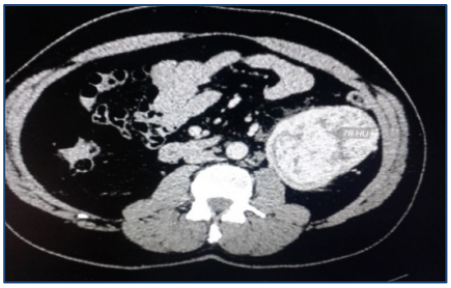


Figure 4: RCC of Lt. kidney (Pre contrast study). Figure 5: RCC (post contrast study)

Table III: The relation between degree of enhancement and type of tumor.

Histopathological types	Mean difference of enhancement	Std. Deviation	P value
Clear cell carcinoma	27.1 HU	7.89439	<0.001
RCC (Chromophobe type)	19.0 HU	1.41421	
Oncocytoma	18.5 HU	2.82843	
Wilms tumor	16.7 HU	3.50238	
Transitional cell carcinoma	9.7 HU	5.25198	
Angiomyolipoma	5.3 HU	4.72582	

According to the homogeneity of enhancement: There is significant difference between type of tumor and pattern of enhancement, 100% of oncocytomas (Figure 6) and transitional cell carcinoma have homogenous patterns of enhancement while 75% of clear cell carcinoma had heterogeneous and 25% are of homogenous. Wilms tumor show 100 % heterogeneous pattern. Angiomyolipoma has 66.7 % homogenous and 33.3 % heterogeneous enhancement, while chromophobe cell carcinoma of 50% for both homogenous and heterogeneous pattern as shown in Table IV.

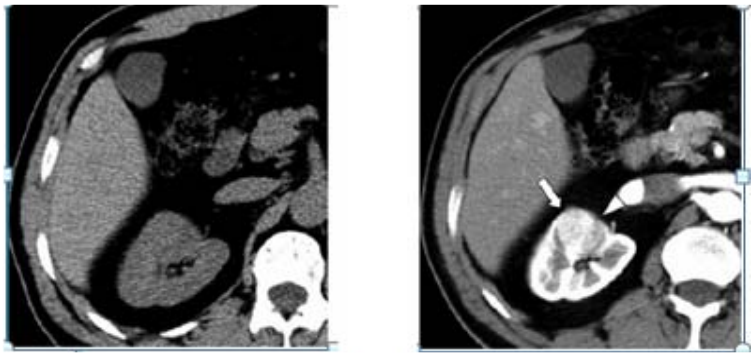


Figure 6: RT. Renal Oncocytoma show small solid mass pre and post contrast with homogenous Pattern of enhancement.

Table IV: Relationship between histological type of tumor and homogeneity of enhancement.

Histopathologic Type	Heterogeneous No.	%	Homogenous No.	%	P value
Clear cell carcinoma	21	75.0%	7	25.0%	0.005
Transitional cell carcinoma	0	0.0%	4	100.0%	0.005
Oncocytoma	0	0.0%	2	100.0%	0.051
Willms tumor	6	100.0%	0	0.0%	0.052
Angiomyolipoma	1	33.3%	2	66.7%	0.244
RCC Chromophobe type	1	50.0%	1	50.0%	0.662
Total	29		16		

According to the relation of the size of tumor and enhancement: The smaller the tumor sizes the more homogenous enhancement seen, and the larger tumor is the more heterogonous pattern as shown in Table V.

Table V: The relation between tumor sizes with enhancement.

Pattern of enhancement	No.	%	Mean size in mm	Std. Deviation	Std. Error Mean	P value
Homogenous	16	35%	18.77.	18.7702	4.69257	0.04
Heterogeneous	29	64.9%	35.	26.5934	5.49537	

Relation between tumor component and homogeneity of enhancement: Solid and solid with central scar tumors significantly differ from solid necrotic tumors regarding pattern of enhancement as solid tumor show 100% homogenous enhancement as in oncocytoma, solid necrotic tumor show 100 % heterogeneous and as in Wilms tumor as shown in Table VI.

Table VI: Relation between tumor component and homogeneity of enhancement.

Tumor component	Homogeneity of enhancement		P value
	Homogenous	Heterogeneous	
Solid	14(100%)	0(0%)	<0.001
Solid necrotic	1(3.3%)	29(96.7%)	<0.001
Solid with central scar	1(100%)	0(0%)	0.173

Discussion

Hounsfield unit (HU) measurements should be obtained and comparison between the unenhanced and contrast-enhanced images should be done to assess and evaluate mass enhancement at CT examination. In the past, with conventional (non helical) CT scanners, a difference of 10 HU was suggested as evidence of enhancement. With the evolution and introduction of helical CT, Chung EP et al at 2004 found that it was realized that there was more variability in the Hounsfield unit readings and that 10 HU was no longer an acceptable threshold with this equipment[17]. At present, there is no universally agreed upon specific number that can be used as definitive and unequivocal evidence of enhancement within a renal mass, and it has been proposed by many authors that the previously used threshold of 10 HU should be increased to 15–20 HU[18]. In characterizing a renal mass, it is important to be aware of the potential unreliability of Hounsfield unit readings, and, therefore, it must be emphasized that no matter what number is used to determine enhancement, any enhancement that is identified must be unequivocal. In some cases, use of the gallbladder or an obvious simple renal cyst as an internal reference standard and comparison of the Hounsfield unit measurements of that reference standard (on the unenhanced and contrast-enhanced images), with the Hounsfield unit measurements of the renal mass can be helpful. However, if there is any question as to whether or not a lesion enhances, another examination (better optimized CT, US in some cases, or MR imaging) should be performed[15].

Renal cell carcinoma was the most common malignant renal tumor in this study which comprise 30 patients (66.6%), and clear cell RCC subtype was the commonest histopathological type among RCC, accounting for 28 patients (93.3%.). Conventional (clear cell) RCC, the most common histopathological subtype, accounts for 80%–90% of all RCCs[12].

Renal cell carcinoma (Chromophobe subtype) seen in two patients. (6.66 %) from all RCC this comparable with Pedrosa et al at 2008 who found that Chromophobe renal tumours account for approximately 4–11% of RCCs and Papillary RCC accounts for approximately 10%–15% of all RCCs and may be multifocal (no papillary RCC in our sample)[19].

Clear cell RCC show largest post contrast enhancement density 27HU. Clear cell RCC mostly enhanced heterogeneously (75%) due to its solid necrotic component which confirm its hypervascularity that is agreed with Zhang J et al at 2003 who found that 90% of clear cell RCCs are hyper vascular with a heterogeneous enhancing pattern of mixed enhancing solid soft-tissue components and low-attenuation necrotic or cystic areas[20].

Marius George Linguraru et al found that the inherent vascularity of conventional RCC characteristically produces strong enhancement in the mass on cortices[21].

Jingbo Zhang et al at 2007 found that most Clear cell RCC commonly manifested with a mixed enhancement pattern of both hyper vascular soft-tissue components and low-attenuation areas that corresponded to necrotic or cystic changes[22]. This pattern was highly predictive of clear cell RCC, also he found that chromophobe lesions tend to enhance moderately that is agreed with our findings (19 HU) degree of enhancement also he found that homogeneous and peripheral enhancing patterns were more predictive of less aggressive Chromophobe lesions our findings are (50% homogenous enhancement) and (50% heterogeneous enhancement).

Jingbo Zhang at 2007 found that Oncocytomas tended to be hyper vascular that is agreed with our finding in which oncocytoma has (18.5 HU) degree of enhancement[22].

Zhang et al. at 2003 found that oncocytoma tended to show a homogeneous and hyper vascular pattern, A central scar can be seen in large oncocytoma[20].

About Wilms tumor Fishman Ek et al at 2013 found that after contrast medium injection, slight enhancement of the tumors was noted, and foci of necrosis became more prominent[23]. Also he found that Wilms tumor show heterogeneous pattern of enhancement that is agreed with our results for Wilms tumor, which show heterogeneous pattern of enhancement (solid necrotic tumor)[23].

bIn our sample, TCC less enhanced with homogenous pattern of enhancement, which is agreed with Matthew S et al at 2011 who found that TCC is hypovascular as they show low enhancement[24] and also Vikram R et al at 2009 found that diagnosis of upper urinary tract TCC is heavily dependent on imaging[25].

Matthew S et al 2011 found that Nonenhanced CT images were superior to contrast enhanced CT images (nephrographic phase) for the diagnosis of AM L and An attenuation threshold of -10 HU or lower with an ROI of at least 19–24 mm is optimal for the diagnosis of AML, which is agreed with our study in which it show low enhancement which was 5 HU[24].

Ali Nawaz et al also found that the demonstration of fatty attenuation in renal tumor on Computed Tomography (CT) scanning studies is virtually diagnostic of angiomyolipoma[26].

Conclusion

1. Contrast enhanced CT Scan is highly valuable in differentiating types of renal masses in correlation with histopathological results.
2. Dynamic abdominal CECT scan can give better results in further evaluation of renal masses in (early arterial, late arterial, venous, delayed phases).

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