Original Research Article

Evaluation of solid renal masses by qualitative and quantitative parameters in four phase MDCT with histopathological correlation

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Abstract

Introduction: Quantitative measurement of the degree of enhancement has not been widely reported for RCC subtypes and fat-poor angiomyolipoma. Previously enhancement in either one of the corticomedullary or nephrographic phases is used for evaluation of renal masses. From the past decade renal mass enhancement is viewed in terms of differences in contrast enhancement and deenhancement patterns over multiple phases on multiphasic MDCT as well as contrast-enhanced MRI to distinguish among RCC subtypes[1]. Most recent studies by Jinzaki et al[11], sun et al and Vargas et al, Stephanie A. Lee-Felkar et al[12] advanced the concept of multiphasic renal mass attenuation profiles for individual histological subtypes. In our study we follow the current novel approach to the imaging evaluation of renal masses using qualitative and quantitative MDCT feature. **Aim/purpose:** To characterize the incidentally detected solid renal masses as benign or malignant and differentiating the clear cell RCC from its benign and malignant mimics based on qualitative parameters like lesion contour, calcifications, neovascularity, enhancement and quantitative parameters like mean absolute attenuation, mean relative attenuation, absolute enhancement & absolute de-enhancement in a four-phase MDCT renal mass protocol. **Materials and methods:** This was an Observational prospective study conducted in 42 patients in the department of Radiodiagnosis at Apollo hospitals, Jubilee hills, Hyderabad referred from the Departments of urology, surgical oncology with a clinical suspicion renal tumors or renal masses which are incidentally detected on ultrasound and referred to CT for further characterizationfor 9 months, from October 2019 to June 2020.Patients of all age groups, both sexes, who were given consent for the study taken and subsequently histopathological findings were followed.Patients with angiomyolipoma with macroscopic fat detectable, predominantly cystic renal masses on CT, Pregnant women and allergic to contrast media are excluded. 128 SLICE PHILIPS INGENUITY CT machine was used for evaluation with parameters of 3mm slice thickness, FOV of 300.00mm, voltage of 120KV, tube current of 300-350mA. **Results:** This was an observational prospective study was conducted among all the patients who were referred to department of radiodiagnosis for further characterisation and correlate with histopathology as gold standard.The mean age of the study population was 49.2 ± 2.9 yrs. with majority of the patients belongs to 41 – 60 yrs.78.5% of patients in the present study were male and 21.5% were female.85.7% were symptomatic at the time of presentation and the most common symptom was haematuria followed by pain in abdomen.Most common solid renal mass was renal cell carcinoma (54%). Among renal cell carcinomas clear cell RCC is most common histological variant (53%). Among the benign oncocytoma is most common (19%). Among qualitative parameters, neovascularity showed statistically significant P value with high sensitivity, specificity, PPV, NPV & accuracy. All lesions showed maximal attenuation in corticomedullary phase and decreased in subsequent phases except papillary variant of RCC. High mean absolute attenuation in CM phase + Mean relative attenuation of >0% in CM phase + absolute de enhancement >50HU has good sensitivity, specificity in differentiating clear cell RCC from others.Progressive enhancement from corticomedullary to nephrographic phase with highest mean absolute attenuation during nephrographic phase had high sensitivity, specificity & accuracy in differentiating papillary RCC from others.Delayed de enhancement more than 30HU differentiated oncocytoma from chromophobe with high sensitivity and specificity. **Conclusion:** Qualitative & Quantitative MDCT features enables diagnosis of malignant masses with 100% sensitivity also discriminating CcRCC from its benign and malignant mimics with high sensitivity and specificity.

Keywords: Four phase MDCT, solid Renal masses, Quantitative measurement

Introduction

Worldwide, renal cell carcinoma (RCC) represents the 6th most frequently diagnosed cancer in men and10th in women, accounting for 5% and 3% of all oncological diagnoses, respectively[1].

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Imaging modalities in the evaluation of renal masses are IVU, USG, CT, PET CT, SPECT and CT angiography. Nowadays, USG is considered a feasible first-imaging option for screening renal tumours[3]. Overall, the echogenicity of the tumour does not differentiate between histological subtypes and cannot reliably distinguish benign from malignant conditions[4,5]. Renal CT scanning is easy to perform, fast, and free of operator dependence and has met with ready clinical acceptance. It is nearly non-invasive with little if any risk except due to use of water-soluble contrast material. The rapid scanning time of helical CT permits renal imaging during three phases of renal parenchymal contrast material enhancement: the Cortical phase, Nephrographic phase, andExcretory phase.The high-

spatial resolution of MDCT leads to an improvement in the detection and characterization of small kidney lesions[6]. CT angiography provides an accurate assessment of the renal vasculature in a fast and efficient manner, without the risks of more invasive conventional angiography. Therefore, the proper characterization of the mass with imaging is essential so that appropriate management is instituted, in addition obviates unnecessary interventions in case of benign and secondary malignant lesions[7,8].

Quantitative measurement of the degree of enhancement has not been widely reported for RCC subtypes and fat-poor angiomyolipoma. Previously enhancement in either one of the corticomedullary or nephrographic phases is used for evaluation of renal masses. From the past decade renal mass enhancement is viewed in terms of differences in contrast enhancement and deenhancement patterns over multiple phases on multiphasic MDCT as well as contrast-enhanced MRI to distinguish among RCC subtypes[1]. Most recent studies by Jinzaki et al[11], sun et al and Vargas et al, Stephanie A. Lee-Felkar et al[12] advanced the concept of multiphasic renal mass attenuation profiles for individual histological subtypes.

Rationale and Purpose of this study

To characterize the incidentally detected solid renal masses as benign or malignant and differentiating the clear cell RCC from its benign and malignant mimics based on qualitative parameters like lesion contour, calcifications, neovascularity, enhancement and quantitative parameters like mean absolute attenuation, mean relative attenuation, absolute enhancement & absolute de-enhancement in a four-phase MDCT renal mass protocol.

CT findings were finally correlated with histopathological examination. In this study sensitivity, specificity, PPV, NPV of four phase MDCT in diagnosing benign versus malignant solid renal masses and also in differentiating clear cell RCC from its other histological variants by using histopathology as gold standard.

Materials and methods

This was an Observational prospective study conducted in 42 patients in the department of Radiodiagnosis at Apollo hospitals, Jubilee hills, Hyderabad referred from the Departments of urology, surgical oncology with a clinical suspicion renal tumors or renal masses which are incidentally detected on ultrasound and referred to CT for further characterization for 9 months, from October 2019 to June 2020.Patients of all age groups, both sexes, who were given consent for the study taken and subsequently histopathological findings were followed.Patients with angiomyolipoma with macroscopic fat detectable, predominantly cystic renal masses on CT, Pregnant women and allergic to contrast media are excluded.128 SLICE PHILIPS INGENUITY CT machine was used for evaluation with parameters of 3mm slice thickness, FOV of 300.00mm, voltage of 120KV, tube current of 300-350mA.

Study imaging procedure

Patients were kept nil orally 4 hrs. prior to the CT scan, risks of contrast administration were explained to the patient and consent was obtained prior to the contrast study.

Routinetopogramof the abdomen was initially taken in all patients in the supine position with the breath held. Axial plain sections of 5 mm thickness were taken from the level of lung bases to the level ischial tuberosity. In all cases plain scan was followed by intravenous contrast scan in suspended inspiration (i.e35–45 g iodine was dosed to weight at a rate of 3 ml/s).A bolus tracking program was used to determine the onset of imaging in the corticomedullary, nephrographic, and excretory phases. An ROI is placed in the thoracoabdominal aorta junction, with a trigger set to begin at 150 HU images in the corticomedullary, nephrographic, and excretory phases were acquired 90, 110 seconds, and 8 minutes after the threshold level of 150 HU was reached.Post study reconstructions were done at 2.5 mm. Sagittal and coronal reconstructions and volume rendering, curved planar reformatting, Maximum and Minimum Intensity Projections were done and when necessary. The magnification mode was commonly employed, and the scans were reviewed on a direct display console at multiple window settings (i.e., abdomen window at 320/40; Lung window 1400/600; Bone window of 2400/200).

The pathological lesions were evaluated with respect to pre and post contrast attenuation values, the size, location of the mass, presence of calcification, presence of fat and extension into the adjoining structures.

Image analysis

Qualitative analysis

Each solid renal mass was evaluated for morphological features such as lesion contour, enhancement pattern, neovascularity and calcification. Enhancement pattern is described as either homogenous or heterogeneous, Lesion contour as smooth or irregular, calcification if present or not. Neovascularity is defined as the presence of increased, irregular, and unnamed vessels in the gerota's fascia adjacent to the involved kidney. The presence of intralesional calcification was assessed on unenhanced CT images. Lesion shape was classified into two subgroups: smooth and ill-defined on enhanced CT images. Lesion attenuation was analyzed on unenhanced CT images.

First, a round or ellipsoid ROI was drawn that covered more than half of the renal lesion. A second ROI with an area of 20–50 mm^2 was placed in the adjacent renal parenchyma. On the basis of morphologic features for each lesion presumptive diagnosis benign or malignant lesion is made.

Quantitative analysis

In quantitative analysis we look for mean absolute and relative attenuation and changes in attenuation across phases. Renal mass attenuation was obtained by placing an ROI in the center of homogeneous lesions and in the maximally attenuating portion of heterogeneous lesions on the imaging phase of maximal attenuation.

Three round or elliptical ROIs not smaller than 0.1 cm^2 were placed in the same location on each of the four imaging phases, such that three ROIs will be present within the maximally attenuating portion of each lesion at the same time. The average value of the three ROIs in each phase was recorded. One ROI is placed in the adjacent uninvolved renal cortex in each phase to normalize for variations in attenuation due to individual patient and technical factors. For example, in patients with mild renal dysfunction, renal artery stenosis, or diminished cardiac output, the timing and magnitude of peak renal cortical attenuation differ, and normalizing renal lesion attenuation to that of renal cortex helps to control for these differences[13]. Areas with calcification or artifact are avoided.

The mean absolute attenuation was calculated as the average of the three ROI measurements in each phase. The relative attenuation was calculated using the formula [(lesion ROI – cortex ROI) / cortex ROI] × 100%. The mean relative attenuation was calculated as the average of the three relative attenuation measurements for each phase. Absolute enhancement from the unenhanced to corticomedullary phases was calculated as lesion ROI corticomedullary – lesion ROI unenhanced, and absolute de-enhancement from the corticomedullary to nephrographic phases was calculated as lesion ROI corticomedullary – lesion ROI nephrographic.

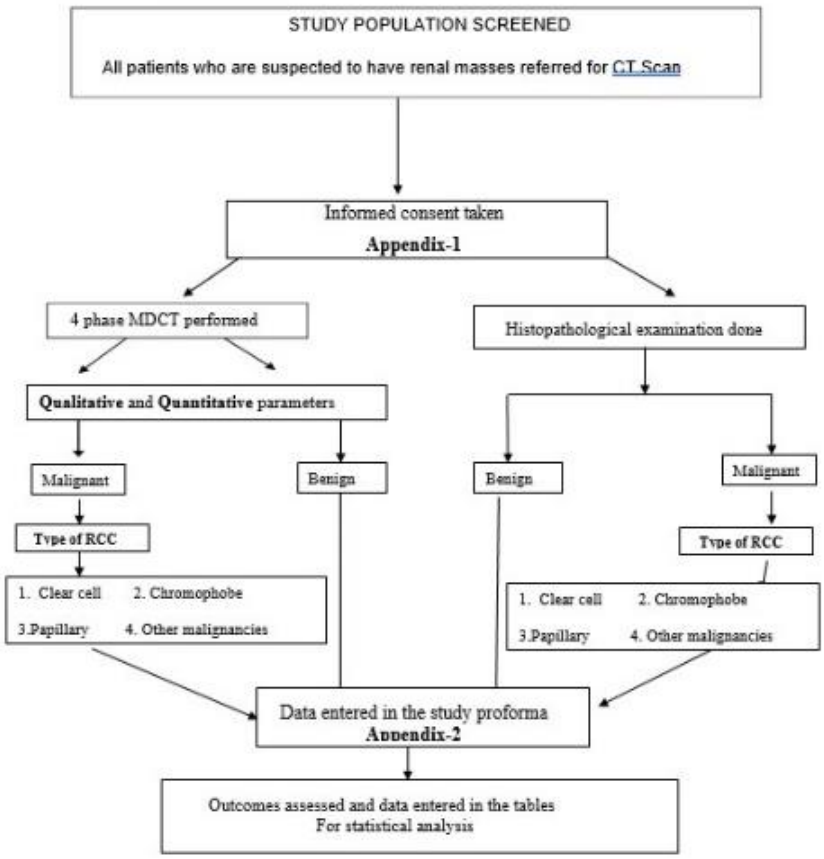
Study statistical analysis plan

All study data from the study proforma sheets were entered into master chart MS excel sheet and data analysis was done using SPSS24.0 version (Statistical Package for Social Sciences) computer software.

All qualitative parameters i.e., Sex, Clinical features, lesion contour, calcifications, neovascularity, enhancement and quantitative parameters i.e. mean absolute attenuation, mean relative attenuation, absolute enhancement & absolute deenhancement were presented with frequencies and percentages and results was presented in the form of tables, charts and graphs.The statistical significance of qualitative parameters was analysed using CHISQUARE test. The

statistical significance of quantitative parameters wereanalysed using ANOVA TEST. Cut off values were calculated using ROC analysis.To find the measure of agreement between CT and histopathology examination we used Kappa statistics along with Sensitivity, Specificity, Positive Predictive Value and Negative Predictive Value. P value of <0.05 was considered significant for all statistical tests.

STUDY FLOWCHART



Results

Among 42 cases, total of 5 cases were identified in 0-20 age group, and all are malignant (4 Wilmstumour, 1 rhabdoid tumor). Peak incidence was between 41-60 years for both malignant (17) and benign (3) tumours.Total 26 RCCs were seen in thestudy maximum cases seen in 41-60 yrage group followed by above 60 yragegroup. Out of 42 cases, 33 (78.5 %) were males, 9 (21.4%) werefemales with male to female ratio was3.6:1.RCC most commonly seen in males (18). Among 4 cases of Wilmstumour, 3 are seen in males and 1 in female with M: F ratio of 3:1.Among benign lesions oncocytoma is seen in 6 males &2 females with M: F ratio of 3:1. 36 (85.7%) cases were symptomatic, while 6(14.2%) cases were asymptomatic (4 cases of RCC, 2 cases of oncocytoma). Most common symptom in the solid renal masses was hematuria (52.5%) followed by pain in abdomen (40%).

A. MDCT features

1. Qualitative parameters

I. Contour lesions

Table 1: showing contour of various solid renal masses.

Type of lesion	Contour of lesion					
	Smooth		Lobulated		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Clear cell RCC	5	33.3%	10	66.6%	15	100%
Papillary RCC	3	37.5%	5	62.5%	8	100%
Chromophobe RCC	0	0%	3	100%	3	100%
Oncocytoma	6	75%	2	25%	8	100%
Lymphoma	1	50%	1	50%	2	100%
Wilm'stumor	0	0%	4	100%	4	100%
Rhabdoid tumor	0	0%	1	100%	1	100%
Metastases	1	100%	0	0%	1	100%

Among 15 cases of clear cell RCC 5 had smooth contour (33.33%), and 10 had ill-defined contour(66.6%). Among 8 cases of papillary RCC3 had smooth contour (37.5%), and 5 had ill-definedcontour(62.5%).All cases of chromophobe RCC had lobulated contour. Among 8 cases of oncocytoma 6 had smooth contour (75%), and 2 has lobulated contour (25%).

Neovascularity of lesions

Table 2: Showing neovascularity in various solid renal masses.

Type of lesion	Neovascularity of lesion					
	Present		Absent		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Clear cell RCC	11	73.3%	4	26.7%	15	100%
Papillary RCC	7	87.5%	1	12.5%	8	100%
Chromophobe RCC	3	100%	0	0%	3	100%
Oncocytoma	2	25%	6	75%	8	100%
Lymphoma	0	0%	2	100%	2	100%
Wilm'stumor	4	100%	0	0%	4	100%
Rhabdoid tumor	1	100%	0	0%	1	100%
Metastases	0	0%	0	100%	1	100%

Among 15, 8 and 3 cases of clear cell, papillary and chromophobe variants of RCC neovascularity is seen in 11(73.3%), 7(87.5%), and 3 (100%) casesrespectively. All cases of wilmstumor and rhabdoid tumor are showingneovascularity. Among 2 cases of lymphoma none showedneovascularity.

Calcifications

Table 3: showing relative frequency of calcifications in various solid renal masses

Type of lesion	Calcifications					
	Present		Absent		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Clear cell RCC	5	33.3%	10	66.6%	15	100%
Papillary RCC	1	12.5%	7	87.5%	8	100%
Chromophobe RCC	1	33.3%	2	66.7%	3	100%
Oncocytoma	1	12.5%	7	75%	8	100%
Lymphoma	0	0%	2	100%	2	100%
Wilm'stumor	1	25%	3	75%	4	100%
Rhabdoid tumor	0	0%	1	100%	1	100%
Metastases	0	0%	1	100%	1	100%

Among all benign and malignant renal masses calcification is seen in oncocytoma, RCC&wilmstumor. Among 15 cases of clear cell variant of RCC, calcification is seen in 5 cases accounting for33.3%%. Among 8 cases of papillary variant 1 showed calcification(12.5%).

Enhancement

Table 4: showing enhancement patterns in various solid renal masses

Type of lesion	Enhancement					
	Homogenous		Heterogeneous		Total	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Clear cell RCC	2	13.3%	13	86.7%	15	100%
Papillary RCC	4	50%	4	50%	8	100%
Chromophobe RCC	0	0%	3	100%	3	100%
Oncocytoma	5	62.5%	3	37.5%	8	100%
Lymphoma	1	50%	1	50%	2	100%
Wilm'stumor	0	0%	4	100%	4	100%
Rhabdoid tumor	0	0%	1	100%	1	100%
Metastases	1	100%	0	0%	1	100%

Among 15 cases of clear cell RCC 2 showed homogenous enhancement (13.3%), and 13 showed heterogeneous enhancement(86.6%). Among 8 case of papillary RCC 4 showed homogenous enhancement (50%), and 4 heterogeneous enhancement(50%).Among 3 cases of chromophobe RCC all showed heterogeneousenhancement. All cases of wilms tumor and rhabdoid tumor showed heterogeneous enhancement.

II. Quantitative parameters

I. Mean absolute attenuation (HU)

Table 5: showing the MEAN ABSOLUTE ATTENUATION (HU) of the renal lesions in various phases- noncontract (NCCT), corticomedullary phase (CMP) and nephrographic phase (NP) and excretory phase.

	Unenhanced	Cortico medullary	Nephrographic	Excretory
Clear cell RCC	34.1 (28.1- 40.2)	169 (162.6-175.5)	93.7 (77.6-109.8)	84.5 (81.8-87.3)
Papillary RCC	33.7 (30.6- 36.8)	63.5 (59-68)	76.8 (69.3-84.3)	57.7 (55.2- 60.2)
Chromophobe RCC	28.9 (19.5-38.3)	131.9 (106.4-157.4)	88.7 (72.1-104.3)	67.3 (60.3-74.3)
Oncocytoma	30.75 (37.4-24.1)	148 (111-185)	123.2 (155.4-91)	78.6 (71-86.3)
lymphoma	37.8 (35.1-40.5)	103.8(91.5-116.1)	83.8 (76.1- 91.5)	71.9 (67-76.8)
Wilms tumor	32.3(26.2-38.4)	121.5(104.8-138.2)	87.2 (80.2- 94.2)	75.6 (71-80.3)
Rhabdoid tumor	34.3	138	88.3	69.4
Metastasis	35.2	134.8	92.3	63.8

All lesions showed maximal attenuation in corticomedullary phase and decreased in subsequent phases except papillary variant of RCC. Papillary RCC was the only lesion with an absolute attenuation less than 70 HU in the corticomedullary phase, and has maximum attenuation in the nephrographic phase.Clear cell RCC had the highest mean absolute attenuation compared with all other histological subtypes. In all cases of lymphoma attenuation of lesion is less when compared with normal renal parenchyma in each phase.

Mean relative attenuation (HU)

Table 6: table showing the MEAN RELATIVE ATTENUATION (HU) of the renal lesions in various phases- noncontrast (NCCT), corticomedullary phase (CMP) and nephrographic phase (NP) and excretory phase.

	Unenhanced	Cortico medullary	Nephrographic	Excretory
Clear cell RCC	106.1 to +26.1)	12.3(8.5 to 16.1)	-11.6(-20.2 to -14.2)	-24(-32.3 to -16.7)
Papillary RCC	17.2(-50.5 to +16.1)	-52.2 (-59 to -49.4)	-58.3(-66.7 to -49.9)	-45.6 (-49.2 to -42.1)
Chromophobe RCC	11.4(-9.1 to +31.9)	-21.6 (-38.4 to -4.7)	-20.4(-28.2 to -11.6)	-29.6(-15.3 to -14.3)
Oncocytoma	4.5(0.8 to 8.3)	-38.7 (-42.1 to -35.3)	-38.5(-44.4 to -32.6)	-27.8 (-33.4 to -22.3)
Lymphoma	10.5(9.2 to 11.8)	-28(-31.4 to -21.8)	-23.6(-31.4 to -15.8)	-22.6(-33.4 to -11.8)
Wilms tumor	-4.3(-2.9 to +11.7)	-32.5 (-42.1 to -22.9)	-46(-54.2 to -37.8)	-25.2(-33.4 to -18.1)
Rhabdoid tumor	14.3	-20.8	-40.8	-41.1
Metastasis	-15.7	-7.4	-32.6	-45.3

Absolute enhancement

Table 7: Showing the absolute enhancement (HU) of the renal lesions from unenhanced to corticomedullary phase.

	AE (Unenhanced to corticomedullary)
Clear cell RCC	139.75 (132.4 to 147.1)
Papillary RCC	45.1 (28.8 to 61.5)
Chromophobe RCC	84.2 (78.5 to 89.9)
Oncocytoma	107.6 (87.2 to 128.1)
Lymphoma	64.2 (49 to 79.4)
Wilms tumor	21.9 (13.1 to 30.8)
Rhabdoid tumor	20.4
Metastasis	94.4

Early absolute de-enhancement

Table 8: showing the early absolute de-enhancement (HU) of the renal lesions from corticomedullary to nephrographic phase

	Early AD (corticomedullary to nephrographic)
Clear cell RCC	72.3 (55.2 to 89.4)
Papillary RCC	8.4 (4.6 to 12.3)
Chromophobe RCC	14.8 (9.3 to 20.3)
Oncocytoma	22.7 (16.8 to 28.7)
Lymphoma	20 (12.9 to 27.1)
Wilms tumor	31.1 (27.2 to 35)
Rhabdoid tumor	15.1
Metastasis	22.9

Delayed absolute de-enhancement

Table 9: showing the delayed absolute de-enhancement (HU) of the renal lesions from nephrographic to excretory phase

	Delayed AD (nephrographic to
Clear cell RCC	9.2 (9.7 to 28)
Papillary RCC	19.1 (14.1 to 24.1)
Chromophobe	21.4 (11.8 to 30)
Oncocytoma	44.6 (84.4 to 31.7)
Lymphoma	11.9 (9.1 to 14.7)
Wilms tumor	11.6 (9.2 to 13.9)
Rhabdoid tumor	18.9
Metastasis	28.5

Illustrations

Clear cell RCC

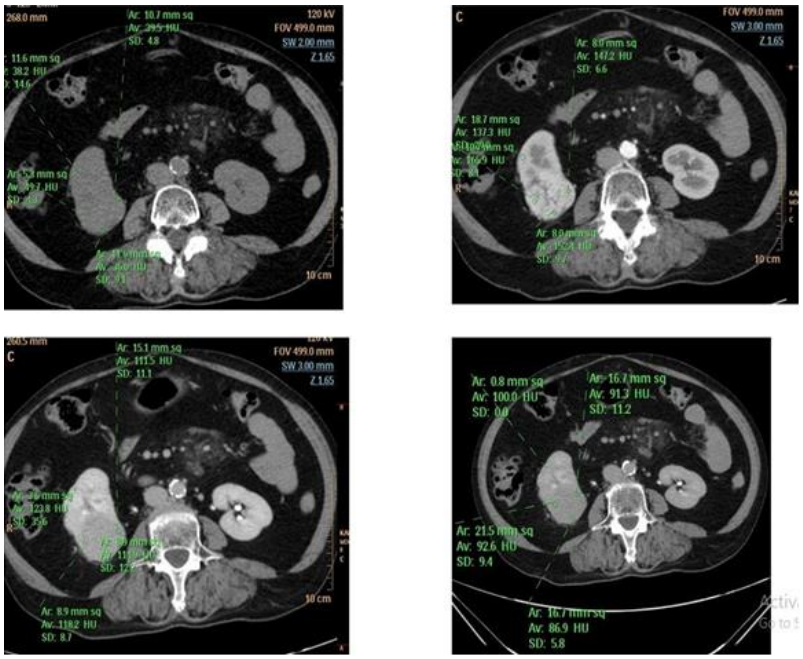


Figure 1: Four phase MDCT scan of 63year female patient with painless hematuria since 3months showed well defined, lobulated, isodense lesion with maximum enhancement during CM phase and maximal early washout suggestive of clear cell RCC. [MAA & MRA of lesion during CM phase is 155.1 & 20.8%. AE (unenhanced-corticomedullary) is 83.3 and early AD (corticomedullary-nephrographic phase) is 57.7.

Chromophobe RCC

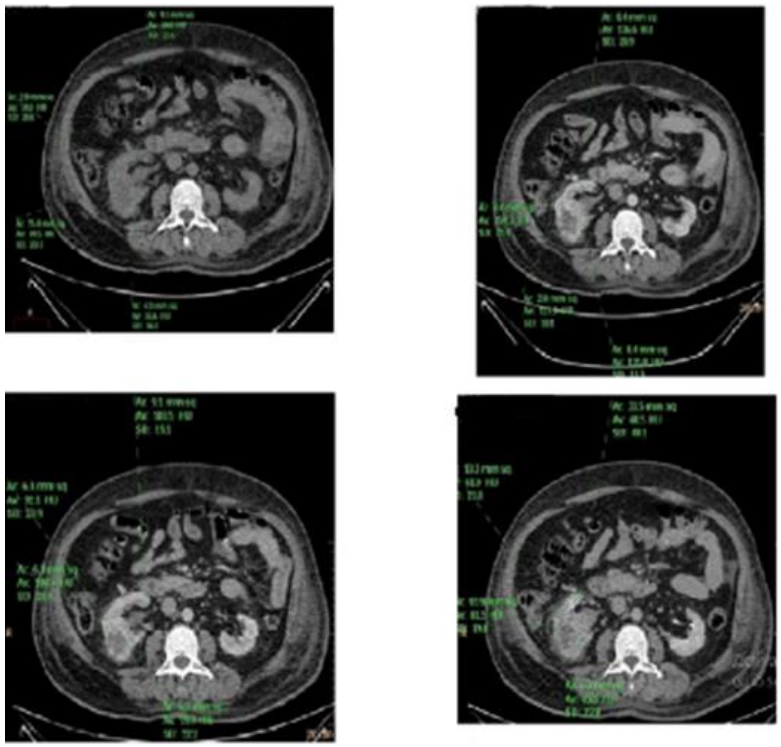


Figure 2: Four phase MDCT scan in a 63 Year male patient with h/o pain &hematuria showed ill defined mass with heterogeneous enhancement on contrast administration in right kidney. Lesion shows maximal enhancement during CM phase + mild early and delayed wash out suggestive of chromophobe variant of RCC. [MAA, MRA of lesion during CM phase 137.8HU, -17.3%. Early AD (corticomedullary-nephrographic) & delayed de enhancement (nephrographic - excretory phase) are 34.3 HU and 18.7 HU].

Papillary RCC

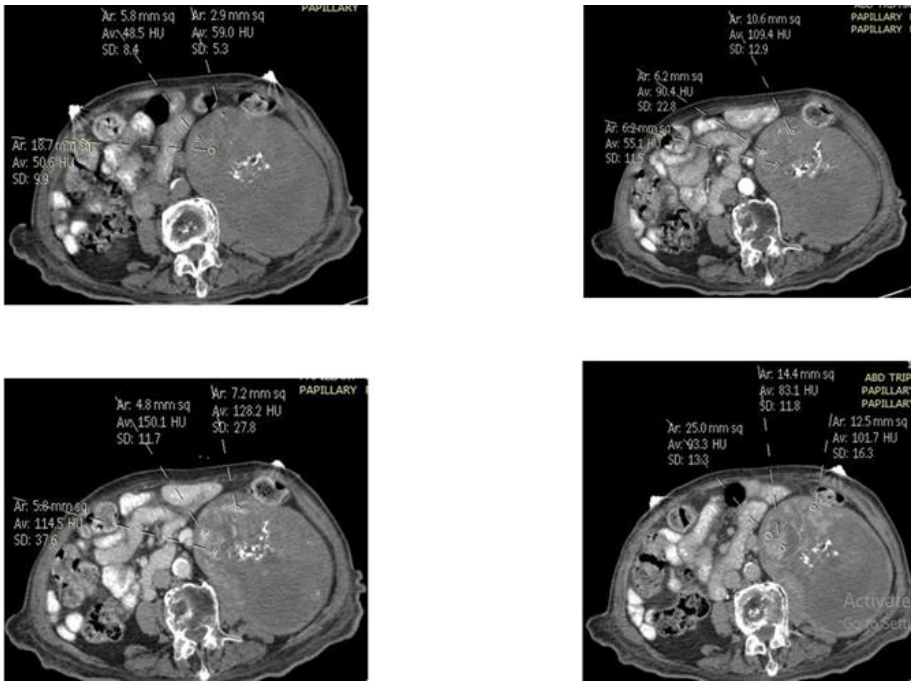


Figure 3: Four phase MDCT scan in an 87 year male patient with h/o lump & pain in left lumbar region showed large well defined lobulated exophytic mass with internal calcifications and with heterogeneous enhancement on contrast administration in left kidney. Mass shows progressive enhancement from corticomedullary to nephrographic phase suggestive of papillary RCC. [MAA of lesion during corticomedullary & nephrographic phases are 84.9 & 130.9 HU respectively. Absolute enhancement of lesion from unenhanced to corticomedullary and from corticomedullary to nephrographic phases are 50.4 & 40.4 HU respectively

Oncocytoma

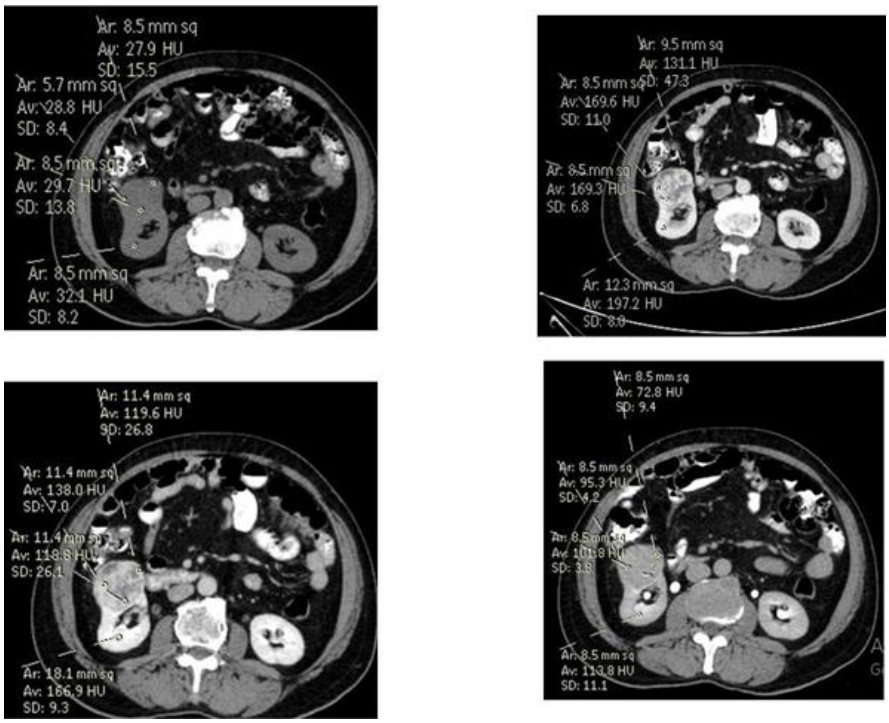


Figure 4: Four phase MDCT scan in a 42Y/F patient with incidentally detected renal mass showed well defined isodense lesion with heterogeneous enhancement on contrast administration in right kidney. Lesion shows maximal enhancement during CM phase and maximal delayed washout suggestive of oncocytoma. [MAA & MRA of lesion in CM phase are 156.6 & -14.3%. AE (un enhanced-corticomedullary) of lesion is 139 & AD (corticomedullary- nephrographic) is 30.5. AD (nephrographic-excretory) is 34.5HU]

Lymphoma

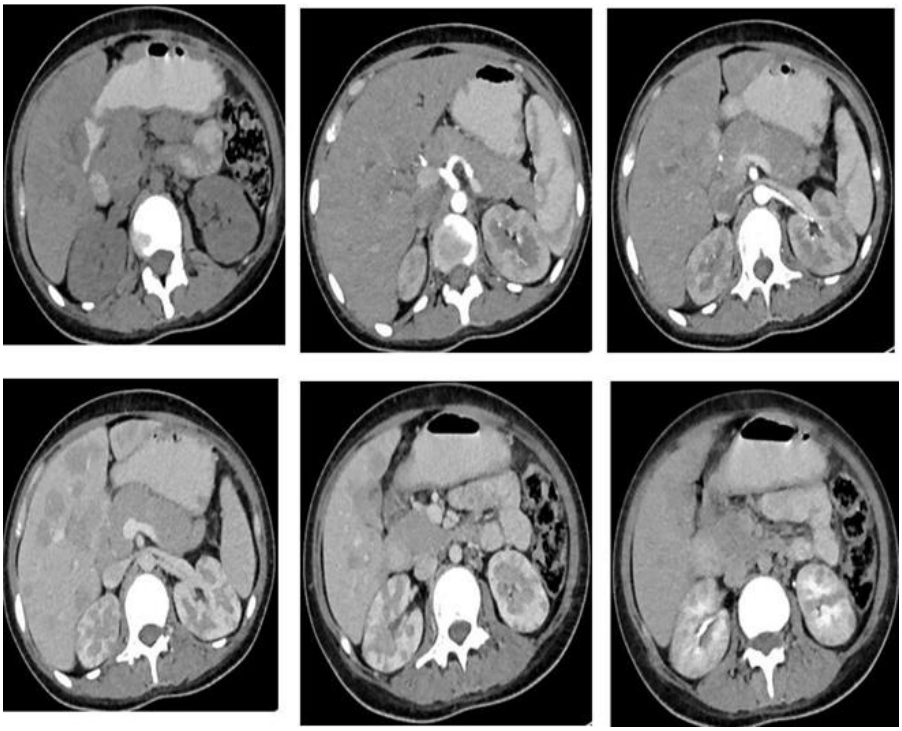


Figure 5: Four phase MDCT scan in an 18Y/F patient with history of fever showed multiple lesions in both the kidneys. During all phases of post contrast scan, attenuation of lesions is less than that of adjacent normal parenchyma. Multiple hypodense lesions are also noted in liver. Diagnosis of lymphoma was considered. Patient underwent USG guided biopsy, which turned out to be lymphoma

Metastasis

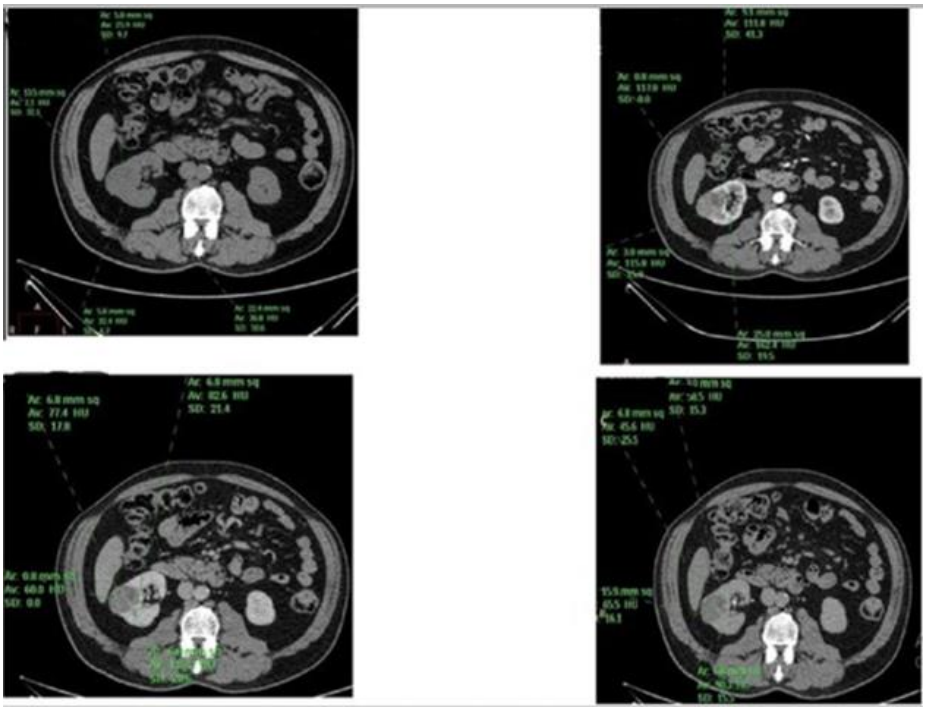


Figure 6: Four phase MDCT scan in a 42Y/M patient, K/C/O testicular germ cell tumor, been evaluated for metastatic work up found to have well defined lesion with heterogeneous enhancement on contrast administration in right kidney MAA of lesion in CM phase is 114.8 HU, MRA is -27.9 HU, Absolute de enhancement from corticomedullary to nephrographic & from nephrographic to excretory phases are 34.4 HU &16HU. As there is a known primary metastasis is considered. Patient underwent simple nephrectomy, lesion turned out to be metastasis from primary germ cell tumor with HPE.

WILMS rumour

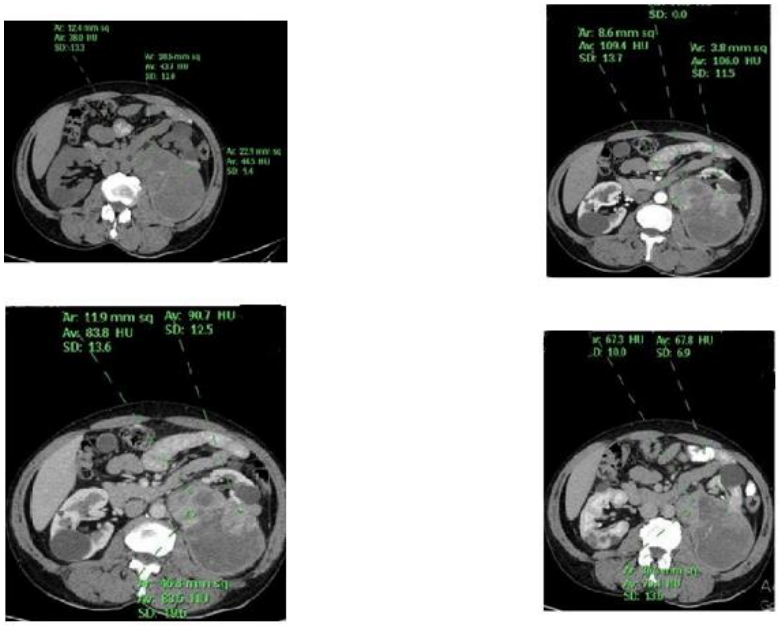


Figure 7: Four phase MDCT scan in a 21Y/M patient with history of lump in left lumbar region showed large lobulated mass with heterogeneous enhancement in left kidney. [MAA & MRA of lesion during corticomedullary phase are 101.8 & - 23.2HU. AE (unenhanced to corticomedullary) is 59.8HU & late AD (nephrographic to excretory) is 17.7 HU].Considering the age of patient diagnosis of wilmstumor is considered. Patient underwent radical nephrectomy & turn out to be wilmstumor with HPE.

Discussion

In our study we used four phase MDCT encompassing the unenhanced, corticomedullary, nephrographic & excretory phases to evaluate enhancement characteristics of each lesion.

The mean age of the study population was 49.2 ± 2.9 yrs with majority of the patients belongs to 41 – 60 yrs.78.5% of patients in the present study were male and 21.5% were female. 85.7% were symptomatic at the time of presentation and the most common symptom was haematuria followed by pain in abdomen. Most common solid renal mass was renal cell carcinoma (54%). Among renal cell carcinomas clear cell RCC is most common histological variant (53%). Among the benign oncocytoma is most common (19%). Among qualitative parameters, neovascularity showed statistically significant P value with high sensitivity, specificity, PPV, NPV & accuracy.

In our study enhancement pattern (homogenous / heterogeneous) of lesions found to be statistically insignificant parameter in differentiating malignant from benign lesions. Calcifications are seen in 7 cases of which 6 turned out to be RCC & 1 oncocytoma. Among RCC 5 are clear cell & 1 chromophobe, but parameter found to be statistically not significant as P value is 0.780. We also evaluated contour for contour of the lesion which found to be insignificant parameter in differentiating malignant from benign lesions with P value of 0.085.

Quantitative analysis was a critical adjunct for differentiating the most common solid renal mass subtypes. On the basis of the significantly higher relative corticomedullary attenuation of clear cell RCC, we were able to differentiate clear cell RCC from all other histological subtypes. We were also able to distinguish clear cell RCC from oncocytoma with high PPV on the basis of two significant features: absolute de-enhancement from the corticomedullary to nephrographic phases and relative attenuation in the corticomedullary phase.

Clear cell RCC had greater absolute de-enhancement than did oncocytoma and significantly higher relative attenuation in the corticomedullary phase. Chromophobe RCC & oncocytoma showed similar negative mean relative corticomedullary attenuation or absolute de-enhancement < 50HU. We further evaluated these two lesions with use of delayed deenhnacement. Delayed deenhancement of >30HU differentiated oncocytoma from chromophobe RCC.

Criteria-I

The combination of higher mean absolute attenuation with mean relative attenuation of greater than 0% or absolute de enhancement (from corticomedullary to nephrographic) more than 50HU differentiated clear cell RCC from rest all lesions with high sensitivity, specificity, PPV, NPV & accuracy.

Table 10: Comparison of sensitivity, specificity, PPV and NPV of criteria-I with previous studies

Criteria-I	Sensitivity	Specificity	PPV	NPV
Present Study	80	81	70	88
Lee-Felker et al[50]	76	70	90	69

In our study papillary RCC showed progressive enhancement from corticomedullary to nephrographic phase with highest mean absolute attenuation during nephrographic phase with high sensitivity, specificity, PPV, NPV & accuracy. 2 cases of lymphoma showed attenuation of lesion less than that of normal parenchyma during all phase of post contrast scan.

Similar studies by **Lee-Felker et al[12]** showed that the papillary RCC was the only lesion with an absolute attenuation less than 70 HU in the corticomedullary phase, and 85.0% (28/33) of papillary RCC had maximal attenuation in the nephrographic phase at a lower absolute mean attenuation than all other subtype.

In present study the combination of higher mean absolute attenuation +mean relative attenuation of less than 0% +mild early

deenhancement + more delayed absolute de enhancement (> 30HU) differentiates oncocytoma from chromophobe with high sensitivity, specificity, PPV, NPV & accuracy.

In present study 4 cases of wilmstumor were identified. Among qualitative features all 4 showed lobulated contour, with presence of neovascularity & heterogeneous enhancement indicating malignant nature of lesions.

Overall in the present study all the 34 malignant masses diagnosis were accurately diagnosed with 100% sensitivity. **Baldari D et al[10]** had also reported 100% sensitivity for malignant masses identification. Decreased sensitivity of phasic MDCT in identification of malignant masses in a study conducted by **Kim JH et al**[11] due to consideration of Bosniak-IIF and III as benign based on percutaneous biopsy, which turned out be malignant after partial nephrectomy. Lee Felker et al study had a large sample size of 165 renal lesions.

Table 11: Comparison of sensitivity of present study for malignant masses identification with previous studies

	Sensitivity for malignant masses identification
Present study	100%
Lee-Felker et al[50]	90%
Kim JH et al[115]	79.7%
Baldari D et al[116]	100%

Table-12: Summary of comparison of demographic, qualitative and quantitative parameters of phasic MDCT with previous studies.

	Mean age (yrs)	Male	Malignant (%)	Sensitivity in identify -cation of malignant renal masses	CRITERIA -1	
					sensitivity	Specificity
Present study	49.2 ± 2.9	78.5%	80.9%	100%	80%	81%
Lee-Felker et al	62.7± 13.1	64.8%	80%	90%	76%	70%
Kim JH et al	63.1	69.1%	88.2%	79.7%		
PatilS et al[14]	53.4± 12.8	63.3%	51.7%	-		
Baldari D et al	61± 17	55.2%	74%	100%		

Most of the solitary solid renal masses are malignant and among the malignant masses, RCC was most common Qualitative & Quantitative MDCT features enables diagnosis of malignant masses with 100% sensitivity also discriminating CcRCC from its benign and malignant mimics with a sensitivity and specificity of 80% and 81%.

Conclusions

This was a observational prospective study was conducted among all the patients who were referred to department of radiodiagnosis for further characterisation and correlate with histopathology as gold standard.

Most common solid renal mass was renal cell carcinoma (54%). Among renal cell carcinomas clear cell RCC is most common histological variant (53%). Among the benign oncocytoma is most common (19%).Among qualitative parameters, neovascularity showed statistically significant P value with high sensitivity, specificity, PPV, NPV &accuracy. All lesions showed maximal attenuation in corticomedullary phase and decreased in subsequent phases except papillary variant of RCC. High mean absolute attenuation in CM phase + Mean relative attenuation of >0% in CM phase + absolute de enhancement >50HU has good sensitivity, specificity in differentiating clear cell RCC from others.Progressive enhancement from corticomedullary to nephrographic phase with highest mean absolute attenuation during nephrographic phase had high sensitivity, specificity & accuracy in differentiating papillary RCC from others. Delayed de enhancement more than 30HU differentiated oncocytoma from chromophobe with high sensitivity and specificity,

Qualitative & Quantitative MDCT features enables diagnosis of malignant masses with 100% sensitivity also discriminating CcRCC from its benign and malignant mimics with high sensitivity and specificity.

Limitations

Small sample size and single centre study. No case of lipid poor angiomyolipoma is present in my study which is a close differential diagnosis of RCC & oncocytoma which can be overcome by increasing the study population, duration of study. In addition, the four phase MDCT renal mass protocol results in a high patient radiation dose. Differences in tumor size and CT technique could account for some of the observed between-patient differences in our study which is a limitation and, however, would not account for observed within-patient and between-phase differences. Since we also included tumors larger than 3 cm in the current study, application of the accuracies reported in our study when determining clear cell RCC from other tumors for suitability in active surveillance protocols is limited and would require further validation in a set of too small solid tumors.

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Conflicts of interest

There are no conflicts of interest.

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