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EVALUATION OF RENAL MASSES WITH MULTIDETECTOR COMPUTED TOMOGRAPHY SCANNER

Radio-Diagnosis

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ABSTRACT

INTRODUCTION: A great number of renal masses are found incidentally as a result of wide use of CT scan, USG and MRI. Sonography may be a screening modality to detect renal lesions, which is followed by computerized tomography (CT) and/or resonance imaging (MRI) for further evaluation. Although MRI can detect and characterize many large renal masses, the spatial resolution is insufficient for diagnosis of small intraparenchymal lesions.

AIMS: To differentiate between cystic and solid masses. To characterize benign v/s malignant renal lesions based on CECT image analysis and to stage malignant masses.

MATERIAL AND METHODS: This study was conducted over a period of 18 months on 50 patients with clinically suspected renal masses attending the Department of Radiodiagnosis of GMCH, Udaipur who were diagnosed with renal masses on ultrasound. The patients underwent CT evaluation of abdomen on a 64-slice volume scanner.

RESULTS: Hematuria was the most common symptom (56%), followed by flank/abdominal pain (42%) and abdominal mass (30%). Weight loss was seen in 8 patients (16%), 6 patients presented with abdominal distension (12%) and 3 with fever (6%). RCC was the most common malignant mass in our study. Hematuria was seen in 94.4%, pain in 13% and abdominal mass in 8%. Out of 18 renal cell carcinomas, 11 lesions were present in right kidney and 7 in left kidney.

CONCLUSION: MDCT with good reformatting techniques and dedicated evaluation of renal masses in different phases of enhancement, has excellent accuracy in detecting the nature and characterization of renal masses.

KEYWORDS

INTRODUCTION

A great number of renal masses are found incidentally as a result of wide use of CT scan, USG and MRI. Sonography may be a screening modality to detect renal lesions, which is followed by computerized tomography (CT) and/or resonance imaging (MRI) for further evaluation. Although MRI can detect and characterize many large renal masses, the spatial resolution is insufficient for diagnosis of small intraparenchymal lesions.

Renal parenchymal tumours are heterogeneous group consisting of benign to highly aggressive/malignant masses. The morphological features and the degree of enhancement vary significantly depending upon the type of tumour. The precise preoperative prediction of the histological sort of lesion is helpful not just for determining the acceptable treatment plan, like the extent of the preoperative evaluation and surgery, but also in preoperative counselling of the patient.

Renal cysts are classified into five categories depending upon the imaging characteristics on contrast enhanced CT according to the Bosniak Classification System of renal cysts. This helps in malignancy risk prediction and also aids in decision making with regards to follow up or treatment.

Benign renal masses outnumber the malignant ones. The ability to distinguish renal cell carcinoma from benign kidney tumours using MDCT characteristics has increased. The histologic subtype of RCC, the nuclear grade, and the cytogenetic features of clear cell RCC have all been demonstrated to be strongly correlated with tumour enhancing characteristics on MDCT. It provides important information such as tumour size, localization, and organ involvement, as well as the presence and extent of venous thrombus, possible invasion of adjacent organs or lymph nodes, and the presence of distant metastases.[1-2]

Renal cell carcinoma represents the commonest primary renal malignancy, accounting for about 2-3% of all cancers.[3] Renal cell carcinoma has a male preponderance with a male to female ratio of 3.2:1. The peak incidence of renal cell carcinoma occur during 6th and 7th decade of life. Smoking, obesity, hypertension, chronic renal failure, chemical and radiation exposure are the predisposing factors of renal cell carcinoma.[4] Wilm's tumor is more common in females and is the second most common intra-abdominal tumor of childhood and fifth most common paediatric malignancy overall.[5] Angiomyolipoma is found mostly in females.

Multidetector Computed Tomography (MDCT) is the preferred investigation because of wide availability, low cost, shorter acquisition time, increased volume coverage and excellent spatial resolution., ability to obtain multiphase imaging, multiplanar and three-dimensional reconstructions in any desired plane bring about further improvement in the evaluation of renal masses.[6] Faster scanning time results in decreased breath hold times with reduction of motion artifacts. Additionally it has been suggested that CT has a major role in evaluating and characterizing renal masses as solid lesions, simple cysts, or complex cysts. This improves the accuracy of region of interest measurement and the imager's ability to characterize the lesion. So subtle features within cystic lesions such as septations, wall thickening and nodularity can be evaluated.

MDCT has dramatically changed the diagnostic evaluation of renal pathologies by allowing rapid image acquisition through the entire kidney during various phases of contrast enhancement after administration of single bolus of intravenous contrast. In general, multidetector CT serves as single step investigation for suspected renal masses.[7] The CT protocol includes an unenhanced acquisition, combined with two or more post-contrast enhanced phases (corticomedullary phase, nephrographic phase and excretory phase). Calcification or fat is detected better with unenhanced CT images. On CECT, if the enhancement increases by 15 HU or more, then it is considered significant.[8]

AIMS

To differentiate between cystic and solid masses. To characterize benign v/s malignant renal lesions based on CECT image analysis and to stage malignant masses.

MATERIAL AND METHODS

This study was conducted over a period of 18 months (Jan 2020 to June 2021) on 50 patients with clinically suspected renal masses attending the Department of Radiodiagnosis of GMCH, Udaipur who were diagnosed with renal masses on ultrasound. The patients underwent CT evaluation of abdomen on a 64-slice volume scanner.

Each subject was worked up and investigated according to the set protocol. History of patients presenting with renal masses was noted. CT was performed on 64-slice volume scanner (SIEMENS SOMATOM Definition).

Patients with simple renal cysts, extra renal mass invading renal parenchyma, deranged kidney function tests and who had allergy to intravenous contrast agents and pregnant women were excluded.

Technique for CT study

An informed consent was acquired prior to CT examination. Risks of the contrast administration were explained to patient. Patients were kept nil orally 4 hrs prior to the CT scan to avoid complications. Routine anteroposterior topogram of 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 tuberosities. In all cases plain scan was followed by intravenous contrast scan in suspended inspiration. The protocol for the CT include image acquisition in pre-contrast, post contrast corticomedullary, nephrogenic and excretory phases.

Routinely 100-120ml of non-ionic contrast was injected at a rate of 3ml/sec in large antecubital vein. The patients were asked to drink 500-750ml of water before the start of examination over a period of 15-20 mins. Sections were taken in craniocaudal direction from the upper pole to lower pole of kidneys in Corticomedullary phase (40-60s), Nephrographic phase (80-120s) and excretory phases(180s).

The arterial phase was a brief period of greatest opacification of the renal arteries that occurs 15–25 seconds following the initiation of intravenous contrast medium administration. In the late arterial phase, the renal veins usually opacified as well.

The corticomedullary (angionephrographic) phase began at about 30–40 seconds after contrast medium injection. The renal cortex enhanced intensely due to preferential arterial flow to the cortex and glomerular filtration of the contrast material, whereas the medulla relatively less enhanced. There was maximum opacification of renal veins in this phase.

The nephrographic phase began at 80–120 seconds after the beginning of contrast medium administration. The renal parenchyma was uniformly enhanced after tubular filtration of contrast material. This was considered the best phase for the detection of subtle parenchymal lesions.

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.

The Bosniak criteria were used to characterise cystic renal lesions. If a lesion appeared well marginated with smooth walls, was internally homogeneous, had attenuation less than 20 HU, was similar to other fluid controls, and was not enhancing following intravenous contrast material administration, it was classified as a simple cyst. If a lesion matched Bosniak's criteria for a type II cyst, such as one or more thin internal septations or minimal mural or septal calcifications, it was termed a minimally complex, radiological benign cyst. Hyperattenuating cysts were also included in this category if they met the other criteria of simple cysts. Class III cysts were moderately complicated cysts. Class IV cysts were cystic carcinoma.

RESULTS

Table 1: Distribution Of Symptoms In Renal Masses

		PAN	MAS	DISTENON	HEMATURIA	FEVER	WEIGHTOSS
		+	+	+	+	+	+
PATHOLOGY	ABSCESS(3)	1	0	0	0	3	0
		33.3%	0.0%	0.0%	0.0%	100.0%	0.0%
	ADPKD(5)	2	2	0	4	0	0
		40.0%	40.0%	0.0%	80%	0.0%	0.0%
	AML(3)	1	2	0	0	0	0
		33.3%	66.7%	0.0%	0.0%	0.0%	0.0%
	COMPLEX CYST(14)	0	1	0	2	0	0
		0.0%	7.1%	0.0%	14.3%	0.0%	0.0%
	HEMATOMA(1)	1	0	0	1	0	0
		100.0%	0.0%	0.0%	3.6%	0.0%	0.0%
	METASTASIS(2)	1	0	0	2	0	2
		50.0%	0.0%	0.0%	100%	0.0%	100.0%
	ONCOCYTOMA (1)	0	0	0	1	0	0
		0.0%	0.0%	0.0%	100%	0.0%	0.0%
	RCC (18)	13	8	5	17	0	6
		72.2%	44.4%	27.8%	94.4%	0.0%	33.3%
	TCC (1)	1	0	0	1	0	0
		100.0%	0.0%	0.0%	100%	0.0%	0.0%
	WILMS(2)	1	2	1	0	0	0
		50.0%	100.0%	16.7%	0.0%	0.0%	0.0%

Table 2: Ct Features Of Masses

		CALCIFICATION	HYDRONEPHROSIS	NECROSIS	RENALVEIN		LYNPH NODES	LYNPH NODES	LIVER	LUNG	ADRENALS	BONES
		+	+	+	LT RV THR	RT RV THR	THR	+				
PATHOLOGY	ABSCESS	0	0	0	0	0	0	0	0	0	0	0
		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	ADPKD	0	0	0	0	0	0	0	0	0	0	0
		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	AML	0	0	0	0	0	0	0	0	0	0	0
		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	COMPLEX CYST	9	0	0	0	0	0	1	0	1	1	1
		64.2%	0%	0%	0%	0%	0%	7.1%	0%	7.1%	7.1%	7.1%
	HEMAT OMA	0	0	0	0	0	0	0	0	0	0	0
		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	METS	0	1	0	0	0	0	2	2	2	1	2
		0%	50%	0%	0%	0%	0%	100%	100%	100%	50%	100%
	ONCOC YTOMA	0	0	0	0	0	0	0	0	0	0	0
		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	RCC	6	1	10	3	2	1	10	6	3	3	4
		33.3%	5.6%	55.6%	16.7%	11.1%	5.6%	55.6%	33.3%	16.7%	16.7%	22.2%
	TCC	0	1	0	0	0	0	0	1	0	0	0
		0%	100%	0%	0%	0%	0%	0%	100%	0%	0%	0%
	WILMS	1	1	0	0	0	0	1	0	1	1	0
		50%	50%	0%	0%	0%	0%	50%	0%	50%	50%	0%
Total	16	4	10	3	2	1	14	9	7	6	7	

Table 3: Distribution Of Individual Renal Masses With Respect To Location

		RIGHT/LEFT			Total
		Right	Left	Both	
PATHOLOGY	ABSCESS	2	1	0	3
		66.7%	33.3%	0.0%	100.0%
	ADPKD	1	0	4	5
		20.0%	0.0%	80.0%	100.0%
	AML	1	1	1	3
		33.3%	33.3%	33.3%	100.0%
	COMPLEX CYST	7	6	1	14
		50%	42.8%	7.2%	100.0%
	HEMATOMA	0	1	0	1
		0.0%	100.0%	0.0%	100.0%
	METASTASIS	1	0	1	2
		50.0%	0.0%	50.0%	100.0%
	ONCOCYTOMA	0	1	0	1
		0.0%	100.0%	0.0%	100.0%
	RCC	11	7	0	18
		61.1%	38.9%	0.0%	100.0%
	TCC	1	0	0	1
		100.0%	0.0%	0.0%	100.0%
	WILMS	0	2	0	2
		0.0%	100.0%	0.0%	100.0%
Total		24	19	7	50

Table 4 :characteristics Of Renal Masses On Mdct With Respect To Attenuation Values On Pre And Post Contrast Scan, A Comparison;

	Renal Masses	N	Mean	SD	Min	Max	F value	P value
UE	Benign	8.00	7.88	29.99	-28.00	44.00	16.022	<0.001
	Cystic	17.00	15.00	4.92	10.00	26.00		
	Malignant	25.00	32.16	5.20	23.00	40.00		
CM	Benign	8.00	20.50	36.93	-20.00	72.00	38.182	<0.001
	Cystic	17.00	16.71	5.38	11.00	29.00		
	Malignant	25.00	77.72	27.04	42.00	161.00		
NH	Benign	8.00	26.75	39.85	-16.00	87.00	70.22	<0.001
	Cystic	17.00	19.00	6.20	12.00	30.00		
	Malignant	25.00	81.84	12.28	60.00	105.00		
Difference (CME-UE)	Benign	8.00	12.63	13.73	1	40	32.71	<0.001
	Cystic	17.00	1.71	0.92	1	4		
	Malignant	25.00	45.56	23.94	12	121		
Difference (NPHE-UE)	Benign	8.00	18.88	18.13	4	55	108.02	<0.001
	Cystic	17.00	4.00	2.94	2	11		
	Malignant	25.00	49.68	9.95	32	76		
Difference (NPHE-CME)	Benign	8.00	6.25	4.56	3	15	0.175	0.840
	Cystic	17.00	2.29	2.34	1	9		
	Malignant	25.00	4.12	22.10	71	38		

BOSNIAK III RENAL CYST

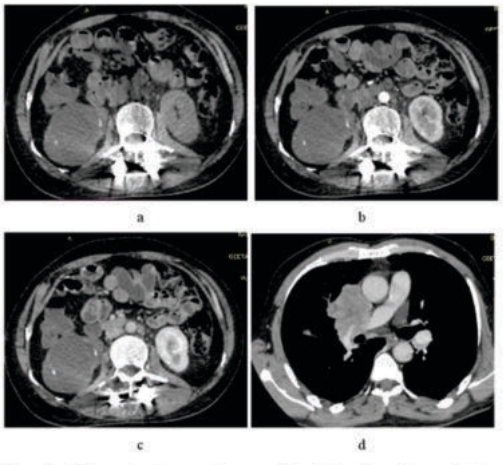

Figure 1: a) Non contrast images shows a multicystic hypodense lesion with internal septations and few foci of calcification noted at mid and lower pole of right kidney. b) & c) Post contrast images show enhancing septae within the lesion. d) Post contrast image of the chest showing soft tissue metastatic lesion noted involving right hilar region abutting and infiltrating the surrounding vascular structure.

AUTOSOMAL DOMINANT POLYCYSTIC KIDNEY DISEASE

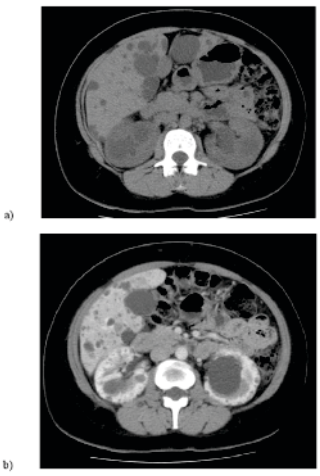

Figure 2: a) & b) Plain non contrast and post contrast images show enlarged bilateral kidneys with multiple cysts of varying sizes in both kidneys which does not enhance on post contrast study. Multiple non enhancing cystic lesions noted in both lobes of liver.

RENAL ANGIOMYOLIPOMA

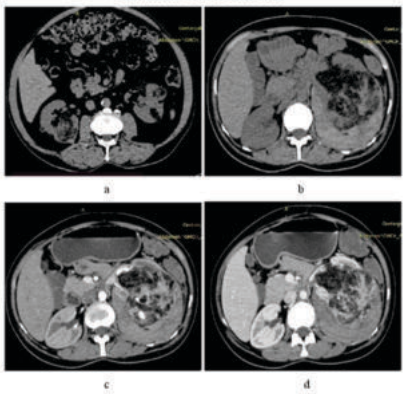

Figure 3: a) Plain non contrast image show multiple soft tissue density lesions with hypodense (fat density) areas within the lesion. b) Non contrast image of a different patient shows enlarged left kidney and a large heterodense lesion with multiple areas of intralesional fat density areas within the lesion. c) & d) Post contrast images show heterogeneous enhancement of the lesion with few dilated tortuous intralesional vessels. There is also associated large ipsilateral subcapsular and perinephric hematoma is seen.

DISCUSSION

Overall, hematuria was the most common symptom (56%), followed by flank/abdominal pain (42%) and abdominal mass (30%). Weight loss was seen in 8 patients (16%), 6 patients presented with abdominal distension (12%) and 3 with fever (6%). RCC was the most common malignant mass in our study. Hematuria was seen in 94.4 %, pain in 13% and abdominal mass in 8%.

Jayson6 studied 131 patients of renal cell carcinoma. Of 131 patients, 80 patients were incidentally detected, 31 presented with hematuria, 13 patients presented with flank pain and 10 with flank or abdominal mass.

Side of lesion	Present study	Amendola et al[7]	Welch et al[8]
Right	11	23	38
Left	7	16	38
Bilateral	-	-	-

Out of 18 renal cell carcinomas, 11 lesions were present in right kidney and 7 in left kidney. Overall most of the renal masses were commonly seen on right side (24), 19 were found on left side and 7 were present bilaterally.

In present study calcification was present in 9 complex cysts (64.2%), 6 RCC (33.3%) and 1 Wilms tumor (50%). Hydronephrosis was seen in 1 metastasis (50%), 1 renal cell carcinoma (5.6%), 1 transitional cell carcinoma (100%), 1 Wilms tumor (50%). Necrosis was seen in 10 renal cell carcinoma out of 18 (55.6%). Renal vein infiltration is seen in 5 cases of renal cell carcinoma out of 18 (27.8%), in which left renal vein invasion was found in 3 cases (16.7%) and right renal vein invasion in 2 cases (11.1%). Inferior vena cava invasion was found in 1 out of 18 cases (5.6%). 10 cases of renal cell carcinoma had lymph

nodal metastasis (55.6%), 6 with liver metastasis (33.3%), 3 lung metastasis (16.7%), 3 with adrenal metastasis (16.7%), 4 with bone metastasis (22.2%). 1 case of Wilms tumor out of 2 presented with lymph nodal, lung and adrenal metastasis (50%). 1 case of Wilms tumor had calcification and hydronephrosis (50%). 1 case of transitional cell carcinoma presented with liver metastasis. Lymph node, lung, adrenal and bone metastasis was found in 1 case of complex cyst (Bosniak type IV) Involvement of renal vein, adrenals, lungs and appendicular skeleton was not seen in benign masses.

Zagoria et al[9] studied CT appearances of 78 pathologically proven RCCs. Of the 61 RCCs larger than 50 mm (78%) there was extrarenal spread in 87%, intratumoral necrosis in 61% and differential growth rates within the tumor in 64%. Tumors 50 mm or smaller often had a "benign" appearance with sharp, rounded margins (88%), homogeneous density (65%), and distinct interface with the kidney (82%). Calcifications were visible in 31% of RCCs. Although 22% of RCCs were predominantly cystic, none fulfilled all CT criteria of simple renal cysts.

In present study all the malignant renal masses showed soft tissue attenuation on the precontrast scans and had a mean attenuation value of 77.7±27.0 in the corticomedullary phase and 81.8±12.2 in the nephrographic phase whereas the benign lesions showed a precontrast mean attenuation of 7.8±29.9, 20.5±36.9 in corticomedullary and 26.7±39.8 in nephrographic phases. The difference in the attenuation between the corticomedullary phase and the nephrographic phases, malignant lesions showed an mean increase by 4.12 HU and benign lesions show 6.25 HU, our findings correlates with findings of the Zagoria et al[9] study.

The mean attenuation values of renal cell carcinoma in the present study is 33.2 HU in unenhanced phase, 66 HU in corticomedullary phase and 84.92 HU in nephrogenic phase. The mean increase in enhancement during corticomedullary phase is 32.7HU and in nephrogenic phase is 51.7HU. All 18 cases of renal cell carcinoma showed greater enhancement in the nephrogenic phase as compared to the corticomedullary phase. Our findings correlated with the study conducted by Birnbaum et al[10] who studied enhancement characteristics of 15 RCCs and concluded that there was progressive enhancement of renal neoplasms with time and the mean enhancement is statistically and significantly greater in the nephrogenic phase than in corticomedullary phase.

In present study complex cystic lesions were present in 14 patients (28%) in the age range of 22-78 years and with the mean age of 54.6 years and male: female ratio of 1.8: 1. Out of 14 patients, a 58 year old female had multiple bilateral renal cortical cysts and parapelvic cyst. Bosniak type II cysts were present in 5 patients. 4 patients presented with Bosniak type IIF cysts and 2 patients had Bosniak type III cysts (were lost in follow up). Bosniak type IV cysts were present in 2 patients which turned out to be renal cell carcinoma and one of them had metastatic lymph nodes and distant metastasis to lung, adrenal and bone.

CONCLUSION

The difference in density was maximum in unenhanced and nephrogenic phase as compared to that in unenhanced and corticomedullary phase, indicating that malignant masses show significant contrast enhancement on corticomedullary and nephrogenic phases as they are highly vascular tumors. MDCT with good reformatting techniques and dedicated evaluation of renal masses in different phases of enhancement, has excellent accuracy in detecting the nature and characterization of renal masses.

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