

# Role of Contrast Enhanced CT in Evaluation of Renal Tumors

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## ABSTRACT

**Introduction:** CT scanning has completely revolutionized the approach to the evaluation of renal tumors and has marked the arrival of a new era in diagnostic radiology. CT has the unique ability to produce anatomy of the kidneys in coronal plane which is well suited to evaluate intrarenal extent of the tumors as well as to evaluate the renal sinus and retroperitoneum. In addition renal perfusion, function and vascular nature of renal tumors can be easily assessed by dynamic CECT. There is a wide spectrum of findings in patients with renal tumors. The purpose of our study was to study in detail the morphology of the renal tumor; e.g. number, size, location, extent, shape, margins, calcifications, density, pattern, enhancement pattern at CECT.

**Material and methods:** The study was carried out after approval from ethical committee of the institution. Forty patients who were diagnosed to have renal tumors by other modalities were included in the study. Contrast enhanced CT examination was performed for all these patients and the findings were evaluated.

**Results:** In our study we came across renal cell carcinoma in 75% of cases, Wilms' tumor in 10%, renal lymphoma in 5% angiomyolipoma in 7.5% and transitional cell carcinoma in 2.5% cases.

**Conclusion:** CT is a very versatile modality for evaluation of renal masses. The initial approach to a patient with a renal mass has to be ultrasound examination as it is cheap, easily available and quickly done. When one has a suspicion that the renal mass is likely to be malignant CT has to be the next step. The disadvantage of CT is that contrast examination is mandatory. Hence patients with deranged renal function cannot be adequately evaluated. The second drawback is the large radiation dose which the patient receives. In these conditions MRI can be a satisfactory alternative.

**Keywords:** CECT, RCC, MRI, Tumors

accurate. For correct preoperative evaluation of renal tumors, the clinician expects an accurate assessment of the morphology of renal tumors, perinephric space, regional lymph nodes, major vessels and adjacent organs, so that he can correctly choose the correct treatment from the available options; viz. surgical resection, interventional techniques like arterial embolisation, chemotherapy, radiotherapy or combinations. The purpose of our study was to detect mass lesions in the kidneys, their morphology and correlate CT study findings with operative and histopathological findings wherever possible.

## MATERIAL AND METHODS

Study was done in Radio diagnosis Department, B J Govt. Medical College, Pune, Maharashtra India. Forty patients of all age groups and both sexes with clinically suspected renal tumors or renal tumors diagnosed by other diagnostic modalities like plain film, intravenous Urography or ultrasonography were subjected to Computed tomography. Patients without clinical suspicion of renal tumors, but incidentally diagnosed on CT were also included in the study. Pregnant women and patient with deranged renal functions are excluded from the study.

**CT scanner used for the study:** Siemens Somatom Definition As + (64 rows 128 slices CT scanner)

**Contrast agents:** Oral as well as intravenous contrast was used for the study.

**Intravenous contrast:** Iopamidol300 was used for the study. Dose used was 300 mg of iodine/kg body weight given intravenously in a bolus dose (about 80ml) in adults. In children Iopamidol 300 was given in the dose of 1.6ml/kg body weight intravenously

**Oral contrast:** Opacification of the gastrointestinal tract was achieved with oral contrast given about 1-2 hours prior to the CT examination. About 1000-1500 cc. of diluted solution of flavored iodinated water soluble contrast was given to the patient orally, followed by 250 cc. of the same solution orally, immediately before the CT scanning.

## INTRODUCTION

The advent of computed tomography (CT) in 1972 by Godfrey Hounsfield provided the urologist a new noninvasive, efficient method for the evaluation of renal pathologies.<sup>1</sup> Before the advent of CT scan, procedures such as plain radiography, intravenous urography, ante grade and retrograde pyelography, angiography, ultrasonography, and radio-nuclide scan were the mainstay in the diagnosis of renal tumors. Improvement in software, hardware, image acquisition and processing, X-ray tubes, detector arrays along with the operational experience gained in last few decades has lead to a dramatic improvement in image quality and the Contrast enhanced CT scan technique (CECT) of the kidneys and other organs. With the advent of newer techniques of CT scanning, evaluation of renal tumors is becoming more

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**Technique**

**Pre procedure instructions**

- a Laxative Tablets of Dulcolax 2 H.S. was given one day prior to the day of scan. Laxatives were not used for pediatric patients.
- b Patient was kept nil by mouth for at least 6 hours prior to scan.
- c Opacification of the bowel was done with oral contrast medium.

**Procedure**

- a. Previous investigations were reviewed before the start of the procedure. Each CT study was monitored and tailored to the clinical problem.
- b. Patient was placed in supine position on the table with both arms over the head.
- c. A digitalized antero-posterior scan gram was obtained and appropriate level of scanning was detected.
- d. CT sections were obtained from the level of dome of diaphragms, including both the kidneys including region of interest within the scan field.
- e. Each scan was done in suspended respiration.
- f. Contrast was given as per the calculated dosage; intravenously through antecubital vein using 18 gauge intra-cath by automatic pressure injector.
- h. Post-contrast scans were obtained in a similar fashion, immediately.
- i. Each lesion was observed for location, shape, size density, and calcification, patterns of enhancement, involvement of adjacent organs, renal vein, inferior vena cava, regional lymph nodes and distant metastases.
- j. In cases suspected of having invaded adjacent organs, CT scanning in decubitus position was done. Attenuation values in Hounsfield units of a suspected lesion were noted in pre and post contrast sections.

The cases thus diagnosed on CT were followed up for their histological diagnosis. The tissue specimen was obtained by biopsy or during operation. The findings at CT scanning were correlated with the operative findings and histopathological diagnosis.

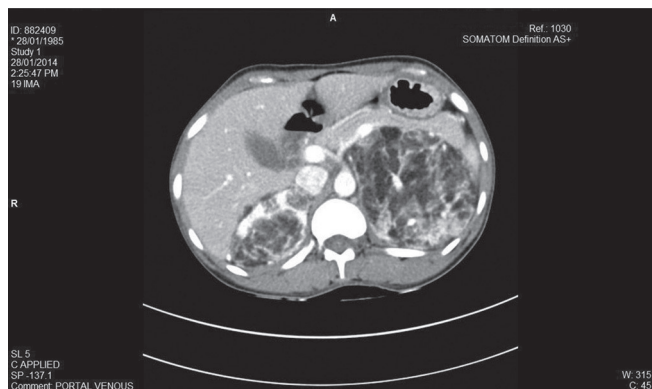
**STATISTICAL ANALYSIS**

Descriptive statistics like mean and percentages were used to interpret the data.

**RESULTS**

Renal cell carcinoma was the most common primary renal parenchymal tumor with an incidence of 75% followed by Wilms' tumor with an incidence of 10%. Wilms' tumor was the most common primary malignant renal parenchymal tumor in childhood. Transitional cell carcinoma was the only renal pelvis tumor, seen in our study with an incidence of 2.5%.

As regards to sex predilection Renal tumors were twice more common in males than in females. Renal cell carcinoma was five times more common in males. Wilms' tumor was commoner in females. Angiomyolipoma was found only in females. There was equal incidence of lymphoma in both sexes. At the time of diagnoses the size of tumor in most cases was 5 to 10 cm. Bilateral tumors constituted 17.5% of all the renal tumors encountered in this study. As regards to attenuation characteristics most tumors were iso to hypodense on non contrast CT. Central necrosis was seen in 60% of renal cell carcinomas. After administration of intra



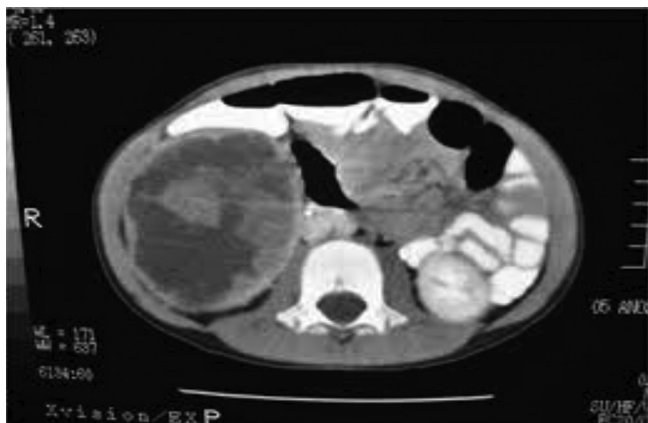
**Figure-1:** CECT of 28 year old female with classical Vogt's triad of tuberous sclerosis shows presence of multiple hypo dense lesions-angiomyolipomas in both kidneys with characteristic negative CT density (CT density of large lesion is -26 HU).

Sr No	Tumour involvement	False positive	False negative	Sensitivity	Specificity	Overall accuracy
1.	Confined to renal capsule	2	1	91%	78%	85%
2.	Invasion of perinpheric fat	1	2	78%	91%	85%
3.	Vessels					
	A) main renal vein	1	1	83%	93%	90%
	B) inferior vena Cava	1	0	100%	94%	95%
4.	Regional lymph nodes	1	2	71%	92%	85%
5.	Adjacent organs	2	0	100%	89%	90%

**Table-1:** Accuracy of CT in pre-treatment staging of RCC.

Sr. No.	Stage	Stages of cases corrlted by CT followup	Diagnosed and re-staged after histopathologic examination
1.	Stage I	4 out of 6	67%
2.	Stage II	2 out of 4	50%
3.	Stage III	4 out of 5	80%
4.	Stage IV	3 out of 5	60%

**Table-2:** Comparison of CT staging with histopathology



**Figure-2:** CECT of the abdomen showing a large heterogeneously enhancing lesion in the right kidney along with a peripheral rim of enhancing tissue (pseudo capsule) surrounding the tumour. HPE: Wilms Tumor

venous contrast most tumors showed patchy enhancement. Histopathological confirmation was available in all renal cell carcinomas and amongst this clear cell carcinoma was the most common variant with an incidence of 96%.

Calcification is a very important characteristic of renal cell carcinomas. Central type of calcification was seen in 70% cases, peripheral in 20% and dense extensive calcification in 10% cases.

CT has a major role to play in evaluating extent of disease. A soft tissue mass extending into perinephric space or perinephric soft tissue stranding or thickening of Gerota's fascia along with irregular outline of the tumor was considered as criteria for tumor invasion of the perinephric space. Venous involvement was said to be present, if there was either enlargement or identifiable thrombus inside the renal vein or the inferior vena cava. Also, invasion of the main renal vein or the inferior vena cava was presumed, if they were not delineated after contrast medium injection. A filling defect or decreased density, lack of enhancement or demonstration of collateral vessels was considered as vena caval involvement. If the lymph nodes were larger than 2cm it was considered to be invaded by the metastatic tumor deposits. Lymph nodes between 1-2 cm. were considered equivocally involved. Adjacent organ involvement was diagnosed only, if there was loss of fat plane between the tumor and adjacent structures. Also enlargements of the adjacent organ or change in density in adjacent organ were considered as evidence of organ involvement.

Perinephric extension and invasion of the renal capsule were the most common causes of error. The overall accuracy in pre-treatment staging of renal cell carcinoma using CT scan was 88.3%. If the overall accuracy of CT scan in evaluating renal capsular invasion and perinephric extension is excluded from this, the overall accuracy of CT scan increases to 90%. It has been found that CT scan was less sensitive in detecting perinephric invasion and regional lymph node involvement and less specific in evaluation of tumors confined to renal capsule. CECT was highly sensitive in detection of invasion of inferior vena cava and adjacent organs (table-1, figure

1,2).

This table reveals that there was a better correlation of CT scan findings with histopathological findings with stage III tumors. Evaluation of stage II at CT scanning resulted in maximum diagnostic errors as compared to other stages (table-2).

## DISCUSSION

CT is a relatively easy, simple and accurate modality which is independent of renal function and is relatively free of complications, except for those which may arise secondary to use of intravenous contrast medium for contrast enhancement. Calcifications are easily seen and the nature of the renal masses can be determined by CT scanning.<sup>2</sup>

### Renal cell Carcinoma

Renal cell carcinoma was the most common tumor in our study with median age distribution of 50 years which is similar to the studies of Crojan et al.<sup>3</sup> Perinephric extension and capsular invasion are the most troublesome areas in CT diagnosis accounting for majority of staging errors.<sup>4</sup> In this study, sensitivity of 75% and specificity of 91% respectively was recorded for perinephric extension at CT scanning. We encountered one false positive case in which perinephric soft tissue extension reported on CT turned out to be fibrous tissue at histopathology. There were two false negative cases seen where tumor appeared to be confined within renal capsule at CT scanning, but microscopic extensions were seen at histopathology. These false positive and false negative results of capsular invasion and perinephric extension have resulted in difficulties in differentiating stage-I disease from stage-II disease. Similar difficulty was also faced by Richie et al and Weyman et al.

### Wilms' Tumor

Wilms' tumor was found in 10.3% cases and there was male preponderance in our study. These findings are similar to the study of Currarino et al.<sup>5</sup> Wilms' tumor was present in an adult patient (20 years) in a patient on active Tablets of Dulcolax 2 H.S. was a rare case. Wilms' tumor in adults is rare and represents 0.5% of all renal neoplasms. Only 1% of Wilms' tumors are present over 15 years. Renal cell carcinoma and multilocular cystic nephroma should be considered as differentials in the diagnosis of adult Wilms' tumor. Renal cell carcinoma appears as a solid mass, smaller than Wilms' tumor and is hyper vascular at angiography. Multilocular cystic nephroma is benign and occurs more in young adult females than males. It is well capsulated and shows multiple non-communicating cysts and is hypovascular on angiography. Calcification was not seen in any case. Earlier reports also state that calcification is rare and is seen in only 3-5% cases.<sup>3</sup> In majority of cases, CT provided correct information about the location and extent of the tumor inside the kidney. However due to lack of retroperitoneal fat evaluation of perinephric region, renal vein and inferior vena cava caused difficulties.<sup>3</sup>

### Renal Lymphomas

Primary renal lymphomas are rare as kidneys normally do not contain lymphoid tissue. Secondary involvement occurs

due to disseminated disease or direct contiguous extension of retroperitoneal disease.<sup>6</sup>

In this study we came across two cases of renal lymphoma constituting (5%) of all the renal tumors of this study. Non Hodgkin's lymphoma is commoner than Hodgkin's lymphoma, but the disease pattern remains same in both the conditions. In this study both the cases were proved to be non-Hodgkin's lymphoma at histopathology. Singer et al stated that CT findings of renal lymphoma are non specific and can be seen in other conditions also.<sup>7</sup> Our study also revealed similar features.

#### Angiomyolipoma

In this study we came across two cases of renal angiomyolipoma. Both the patients were teenage females (average age 18.5 years). In one case, the disease was unilateral while in the second there was bilateral involvement of the kidneys. One of the patients presented with classical Vogt's triad of tuberous sclerosis and showed bilateral small multiple renal angiomyolipomas. In addition to renal findings, CT also showed presence of hamartomas in liver which were identified by the characteristic presence of fat inside these lesions. CT scan of brain also showed multiple periventricular calcific densities typical of tuberous sclerosis lesions in the brain. Fundoscopy of the eyes showed characteristic potato tumors of retinal angiomas. X-ray hands and pelvis showed typical sclerotic lesions of tuberous sclerosis in the bones. Renal angiomyolipoma has to be differentiated from renal lipoma, retroperitoneal liposarcoma and renal cell carcinoma at CT. Presence of fat in the renal tumor is a sure indicator of renal angiomyolipoma; however, presence of solid density component causes diagnostic difficulties with renal cell carcinoma<sup>8</sup>

**Limitations of our study:** Small sample size and lack of availability of histopathological diagnoses in all the patients are the limitations of our study.

#### CONCLUSION

CT is a very versatile modality for evaluation of renal masses. The initial approach to a patient with a renal mass has to be ultrasound examination as it is cheap, easily available and quickly done. When one has a suspicion that the renal mass is likely to be malignant CT has to be the next step. The disadvantage of CT is that contrast examination is mandatory. Hence patients with deranged renal function cannot be adequately evaluated. The second drawback is the large radiation dose which the patient receives. In these conditions MRI can be a satisfactory alternative.

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