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Characterization of solid renal masses using MDCT.

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Abstract
Background *Renal cell carcinoma (RCC), the most prevalent form of kidney cancer, accounts 3% of all cancer cases. Treatment of the patient depends on the early detection of malignant tumors and their distinction from their benign equivalents. With its rapid scanning times and ability to reformat, multi-detector computed tomography (MDCT) has become an essential technique for the identification and characterization of renal masses.*

Materials and Methods *The present study is a cross-sectional, observational study undertaken to assess the role of MDCT in characterization of the renal masses with patients being referred with suspicion of renal mass to the department of radiology at NRI Medical College and GH Chinakakani.*
A 16 slice multi-detector computed tomography was used to examine all of the study participants.

Results *In our study, out of 50 patients, 64% were males and 36% were females. Renal cell carcinoma was the most common lesion in our study group (66%) followed by angiomyolipoma (8%). Most common presenting symptom was pain abdomen (74%) followed by hematuria (38%). ConsideringHPEasgoldstandard, the sensitivity of CT in detecting malignancy was 93%, specificitywas100% and overall diagnostic accuracy was 94.12%.*

Conclusions *MDCT is an excellent tool which can provide details on the extent of lesion, enhancement pattern of lesion, invasion into surrounding structure. It is possible to differentiate between a benign and malignant renal tumour so that the doctor can decide on the best course of treatment.*

Keywords: Multi-detector computed tomography (MDCT), Renal mass, Renal cell carcinoma (RCC), Hematuria, Enhancement.

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I. Introduction:

Renal cell carcinoma (RCC), the most prevalent form of kidney cancer, accounts 3% of all cancer cases[1]. One of the best technologies for evaluating the abdomen is MDCT, which has contributed to numerous advancements in the characterization of renal masses.

With its rapid scanning times and ability to reformat, multi-detector computed tomography (MDCT) has become an essential technique for the identification and characterization of renal masses. As more studies are conducted every day, more renal masses are currently being unintentionally or incidentally discovered. It was a commonly used and favored method for staging and locating any metastases as well as any suspected kidney tumors. Benefits include inexpensive price, high reliability, and easy availability[2].

Low acquisition times and the ability to use contrast agents allow MDCT to be used to detect any enhancement during its three phases. Later, computer-based methods can reassemble the data that was obtained. It contributes to improving the precision of the region of interest (ROI) for measurements and lesion characterization. It is also simple to assess subtle lesions characteristics such septations, wall thickening, and nodularity. Consequently, MDCT is regarded as the best method for describing renal masses (3).

Themostcommonrenalmassesaresimplecysts.Benignmassesaremorecommonthanmalignantmasses.Thefastscantimeof MDCTenablesimagingofthekidneyineachofthenon-contrastandthreecontrast-enhancedstages. corticomedullary(30-60seconds),nephrographic(80-120seconds),andexcretoryphase(180-300seconds).Unenhancedimageshelpbetteridentifycalcificationorfat[4].CThasnowreplacedangiographyandultrasound(USG)intheevaluationofrenalmasses.ThediagnosticaccuracyofCTindifferentiatingbetweencystsandneoplasmsishigh.

AccordingtoGlobocandata,431,288patientswillbediagnosedwithkidneytumorsin2020,accountingfor2.2%ofallcancerdiagnoses[5].Ofthese,approximately254,500werediagnosedinmenand148,800inwomen,witharelativeriskformenof1.7[6].

II. Materials and Methods

Method of data collection: The present study is a cross-sectional, observational study undertaken to evaluate the role of multi detector computed tomography in characterization of renal mass in patient being referred to the department of radiology, the NRI Medical College, and GH Chinnakakani with suspicion of renal mass.
Study design: Cross-sectional, observational study
Study location: Department of Radiology, the NRI Medical College, and GH Chinakakani.
Study duration: December 2021 to December 2022
Sample size:50
Sample size calculation:
The sample size is calculated as:
$N=Z^2PQ/E^2$
N-Samplesize
P-Prevalence
P=1%
Q=1-P
E-Error: 2%,
95% confidence limits
N=49
49 is the minimum size
So, we included 50 patients in this study, considering few lost to follow up cases.All 50 patients provided consent for the study.

Subjects and selection method: All the study patients were investigated on a 16 slice GE Bright speed CT system. Age, gender, symptoms, enhancement pattern and additional findings were assessed in all patients.

Inclusion criteria:
1. Patients with renal mass suspected clinically and diagnosed by ultrasound.
2. Patient of any age and gender.
3. Patients who provided informed consent to participate in the study

Exclusion criteria:
1. Patients who were allergic to contrast.
2. Patients with severe hepatic and renal abnormalities.
3. Pregnancy and lactating women.
4. Patients with lesions of the abdomen other than renal lesions.
5. Patient with simple renal cysts diagnosed on ultrasound.

Imaging protocol: Plain 5mm axial sections were taken from diaphragm to ischial tuberosity at120KVpand300mAs. Next,axialsectionswereacquiredinthecortico-medullary (30-60s),nephrographic (80-120s) and excretory (180-300s) phases in cranio-caudal direction after givingcontrastby pressureinjectorat the rate of 2-3ml/second. TheIVContrastmaterialusedwasIOHEXOL-whichcontains350mgiodine/mlatadoseof1ml/kg. Retrospective reconstruction was performed by 0.625mm slice thickness insagittalandcoronalplanes. Whereeverneeded,theintensityprojectionandvolumerenderingtechniqueswereassessed.

Statistical analysis The data collected was entered in MS Excel 2019 and analysis was carried outusingMicrosoftexcelandstatisticalsoftwarecalledEpi infoversion7.2.5. The resultswereexpressedin theformofdescriptivestatistics. Frequencies,percentageswerealsoused. Continuous variableswereassessedusingmeanandSD. Diagnostic tests are evaluated with the help of various measures of diagnosticaccuracy such as specificity, sensitivity, positive predictive value (PPV),negativepredictivevalue(NPV).Theseareknownasperformanceindicators.

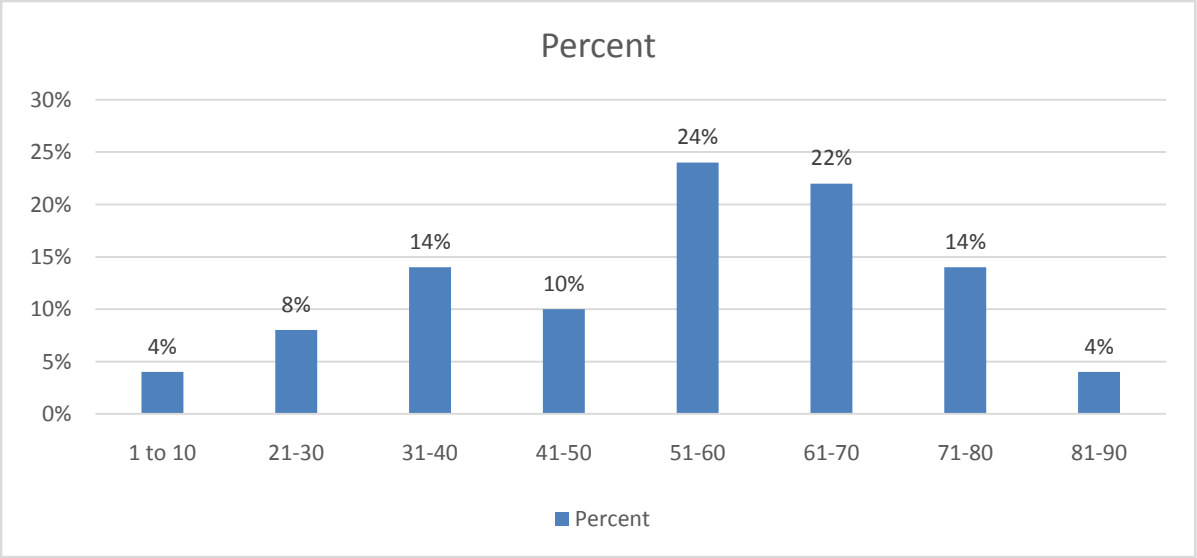
III. Results

Age distribution:24% patients were aged 51-60 years, 22% of patients were aged 61-70 years, 14% were aged 31-40 years, 14% were aged 71-80 years, 10% were aged 41-50 years and 8% were aged 21-30 years.

Table 1: Age distribution

AGE GROUP	Frequency	Percent
1-10	2	4%
21-30	4	8%
31-40	7	14%
41-50	5	10%
51-60	12	24%
61-70	11	22%
71-80	7	14%
81-90	2	4%
Total	50	100%

Graph 1: Age distribution



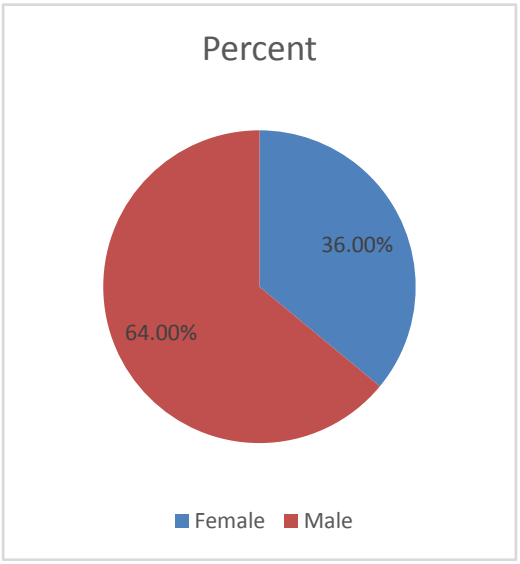
Mean age:
Themeanageis53.5years.
Agerangedfrom3yearsto83years
Gender distribution:

64% were males and 36% were females. This indicates that renal masses were more common among males.

Table 2: Gender of patients

SEX	Frequency	Percent
Female	18	36.00%
Male	32	64.00%
Total	50	100.00%

Graph 2: Gender of patients

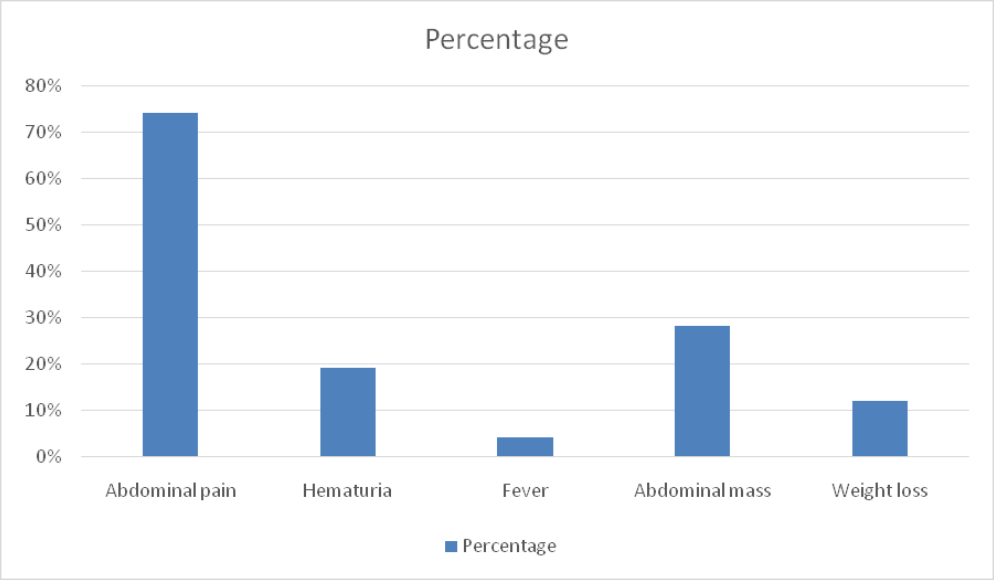


Symptoms:
74%ofpatientswerehavingpain
38% of patientswere havinghematuria
4% of patientswerehavingfever
28%ofpatientshadabdominal mass
12%of patients had weight loss

Table 3: Symptoms

Symptoms	Frequency	Percent
Abdominal pain	37	74.00%
Hematuria	19	38.00%
Fever	2	4.00%
Abdominal mass	14	28.00%
Weight loss	6	12.00%

- **More than one symptoms was seen in one patient.**



Graph 3: Symptoms

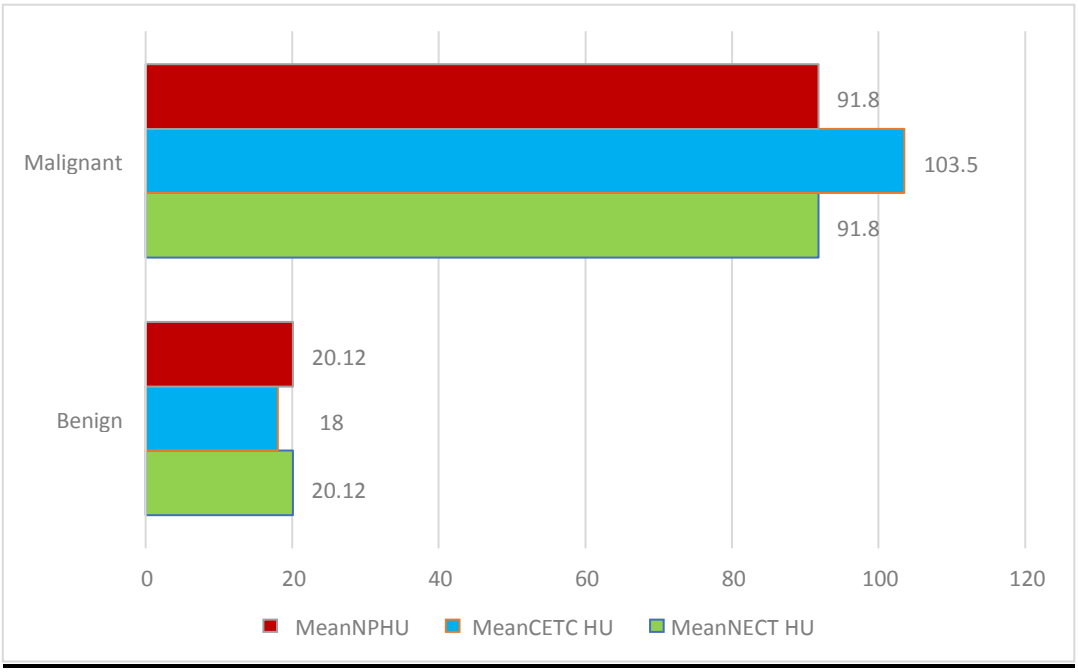
Enhancement:

Themean non enhanced CT (NECT)HUinbenignlesionwas20.12anditwas91.8in malignant lesions.Themean Cortico-medullary phase (CMP)HUinbenignlesionwas18.0anditwas103in malignant lesions.Themean nephrographic phase (NP)HUinbenignlesionwas20.12anditwas91.8inmalignant lesions. Thereissignificantdifferenceinmean HU between benignandmalignantlesions in all phases. Mean HU was more in malignant than benign lesions in all phases.

Table 4: Enhancement

Type ofTumor	MeanNECTHU	MeanCMPHU	MeanNPHU
Benign	20.12	18.0	20.12
Malignant	91.8	103.5	91.80

NECT- Non enhanced CT, CMP- Cortico-medullary phase, NP - Nephrographic phase

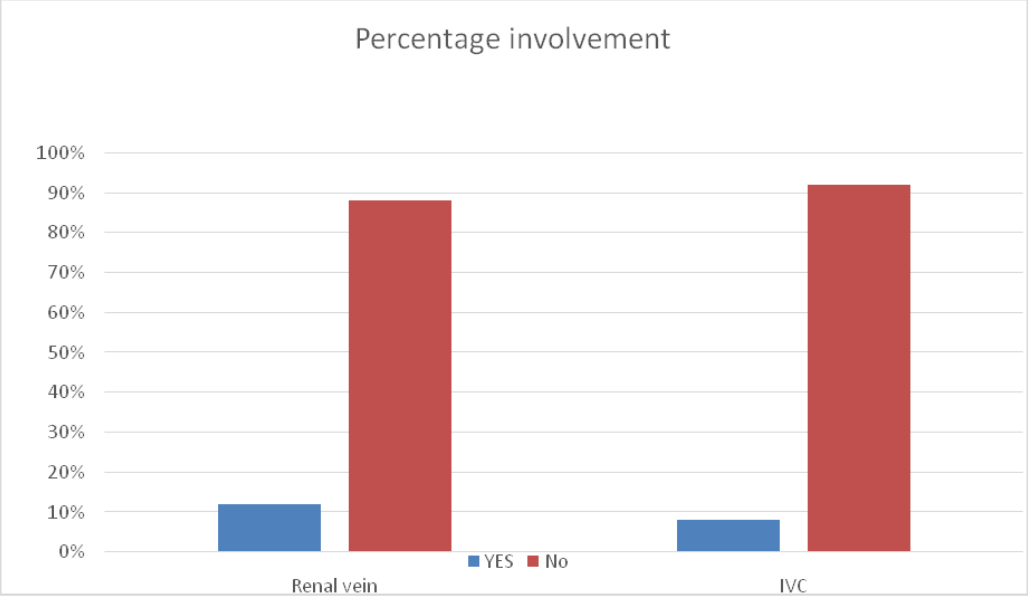


Graph 4: Enhancement

Renal vein and Inferior vena cava involvement:
Renalveinwasinvolvedin12%patients.Inferior vena cavawas involved 8%of patients.

Table 5: Renal vein and IVC involvement

Involvement		Frequency	Percent
Renal vein	**Yes**	**6**	**12%**
	No	**44**	**88%**
IVC	**Yes**	**4**	**8%**
	No	**46**	**96%**

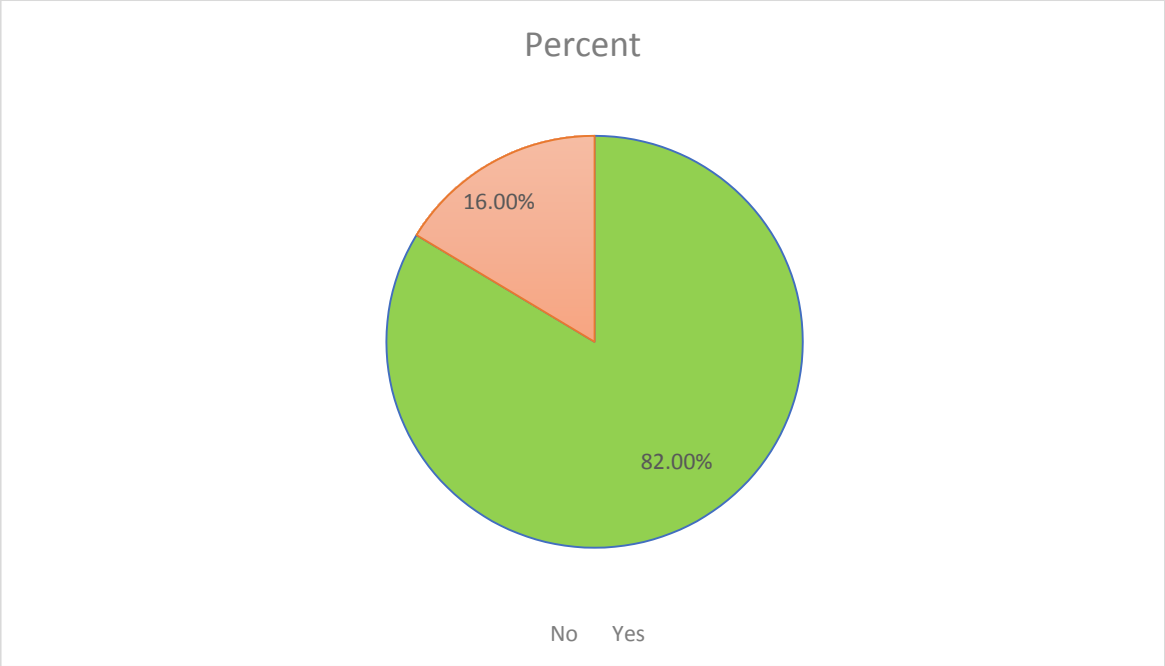


Graph 5: Renal vein and IVC involvement

Lymph nodes: Lymphnodalinvolvementisseenin16%ofpatients.

Table 6: Lymph nodal involvement

LN	Frequency	Percent
No	41	82.00%
Yes	9	16.00%
Total	50	100.00%

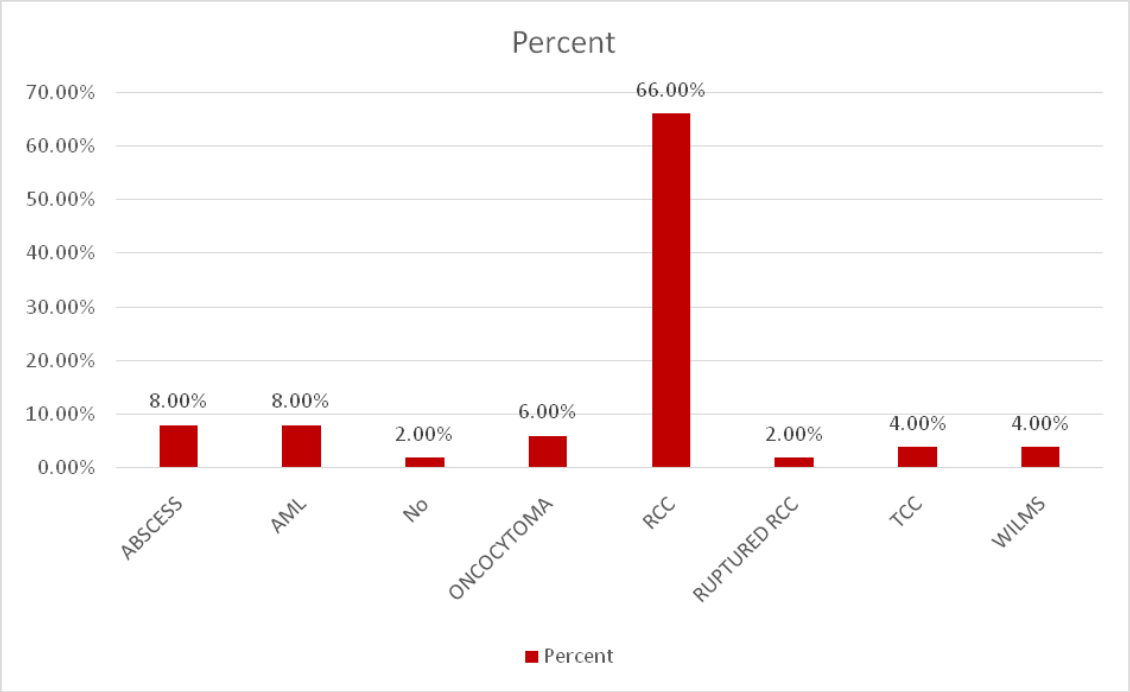


Graph 6: Lymph nodal involvement.

CT diagnosis:
Abscess was seen in CT in 8% of patients.
No abnormalities in 2% of patients
RCC was seen in 66% of patients
Transitional cell ca was seen in 4% of patients.
Wilms tumor was seen in 4% of patients.
Oncocytoma was seen in 6% of patients.

Table 7: CT diagnosis.

DIAGNOSIS	Frequency	Percent
ABSCESS	4	8.00%
AML	4	8.00%
No	1	2.00%
ONCOCYTOMA	3	6.00%
RCC	33	66.00%
RUPTURED RCC	1	2.00%
TCC	2	4.00%
WILMS	2	4.00%
Total	50	100.00%



Graph 7: CT diagnosis.

HPE findings:
Abscess was seen in 8% patients.
Clear cell RCC was seen in 56% of patients, hematoma in 2% of patients, papillary RCC was seen in 16% of patients.
Oncocytoma was seen in 4% of patients.
AML was seen in 6% of patients.
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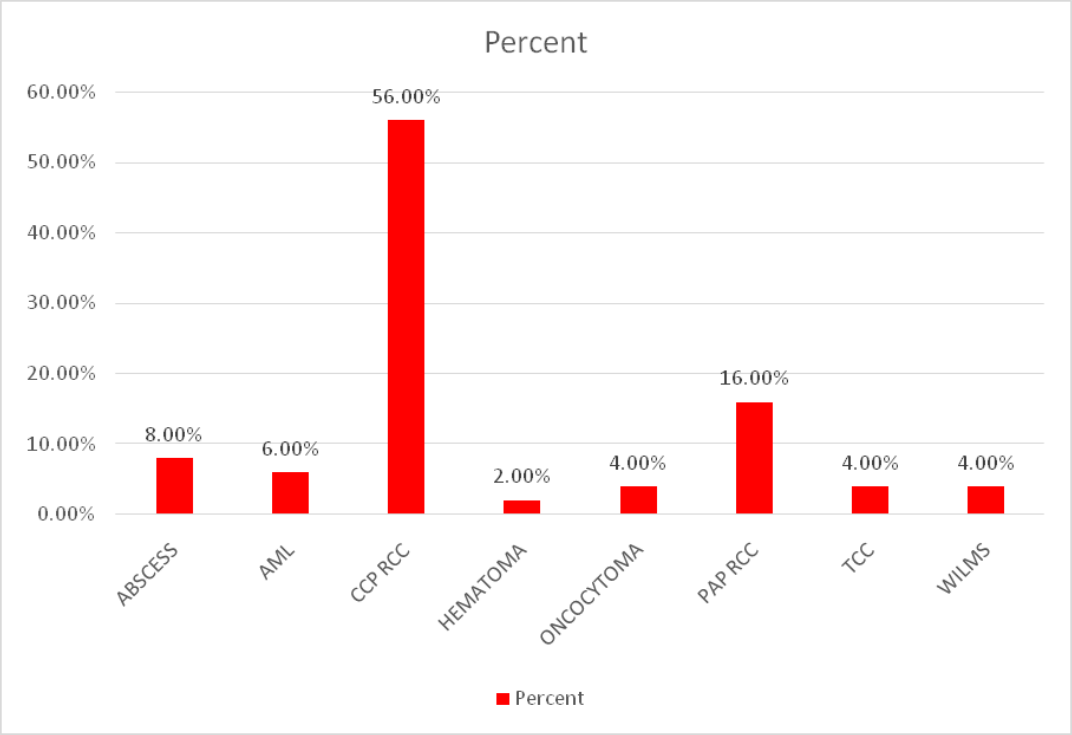
Table 8: HPE findings.

HPE	Frequency	Percent
ABSCESS	4	8.00%
AML	3	6.00%
CCP RCC	28	56.00%
HEMATOMA	1	2.00%
ONCOCYTOMA	2	4.00%
PAP RCC	8	16.00%
TCC	2	4.00%
WILMS	2	4.00%
Total	50	100.00%



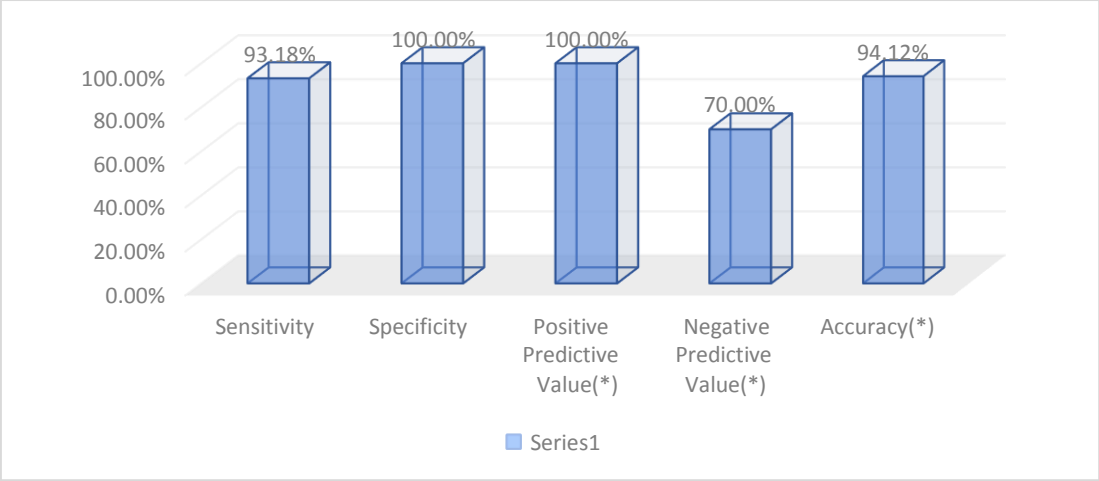
Graph 8:HPE findings

Sensitivity,specificityofCTindetectingrenalmalignancy:
Considering HPEasgoldstandard,therewere41truepositivecases,7truenegativecasesand3falsenegativecases.ThesensitivityofCT indetectingmalignancy was93%, specificity was 100%, PPVwas 100%NPVwas70%andoverallaccuracywas 94.12%.Overall,therewere 80%malignantmassesand20%benignmassesasperHPE.

Table 9: Diagnostic accuracy of CT

Sensitivity	93.18%	80.52%to98.50%
Specificity	100.00%	66.37% to100.00%
NegativeLikelihoodRatio	0.07	0.02to0.21
Diseaseprevalence(*)	82.35%	69.13%to91.60%
PositivePredictiveValue(*)	100.00%	
NegativePredictiveValue(*)	70.00%	50.20%to89.93%
Accuracy(*)	94.12%	83.76%to98.77%

Graph 9: Diagnostic accuracy of CT



IV. Discussion

RCC [7-9]:

RCC, which is adenocarcinoma pathologically is commonest renalmalignancyamountadults. Itismorecommonamongmales. ClearCellRCCorconventionalRCC iscommonesthistologicsubtype,constitutingfor70%ofallRCCs.
ClearcellRCCscommonlyshowhypervascularityonCT,MRIandangiography. Theimaging showsfocalrenalmassthat ispresentinthecenterof renalcortex.Masswilldisruptthemarginsin manycases, irrespectiveoftumoursize. Cystsmaybeseenin15%ofcasesandcalcificationcanbeseenin10%–15% ofcases.Largemassmayhavemorecalcificationscomparedtosmallmassed. Metastasis is commonly seento lungs,liver, bone and soft tissues.
Degree of contrastenhancement(CE)helps to differentiateclear cellRCC fromnon–clearcelltypes. ClearcellRCCshowenhancementabove84 HU incorticomedullary phase (CMP)and44HUduringexcretoryphase. Comparedtootherforms ofRCC,papillaryRCCsareusuallylessvascular andmost frequently presentashomogenousorperipheralenhancement. Papillary RCC was strongly suggested by low tumor-to-aorta enhancement ratiosortumor-to-normalrenalparenchymaenhancementratios. Whereas inchromophobe RCCdegreesandenhancingpatternaremore varied.

WILMSTUMOUR[10]:

Wilms tumourisa commontumouramongchildren. Thetumourcommonly occursinchildrenaged3to4years.ItwascommonlylinkedtoWAGRsyndrome that includes Wilms, GU abnormalities, aniridia, retardation, and DRASHsyndrome.
Patientswereusuallyagedbelow4yearsofage.
It appearslikealarge,spherical,partialintrarenalmasswithsoftdensityon CTandMRSIislesscomparedtonormalrenalcortexonT1WI. ItismorethannormalparenchymaonT2WI. TumourshowsenhancementafterIVinjectionofcontrastbuttoalesserextentthansurroundingparenchyma. Mostof the tumorsareheterogeneous,asthey shownecrosisorhemorrhage.Calcificationscanbeseenrarely. Localspreadthroughthecapsuleinto perinephricspaceandretroperitoneallymphadenopathyorRVorIVCthrombosismaybeseenrarely.Perinephric extensionwillseenasthickenedcapsule ornodules.
Normal-sizenodescanbecommonlyseenonabdominalCTandMRIamong adults,butthesearerarelyseenamonginfantsandyoungchildren.

ONCOCYTOMA:

It is a benign tumour. It is a solid, enhancing mass with various features similar to RCC. Oncocytomas are common among males. And around 80% doesn't have any symptoms. On CT, oncocytomas are usually solid with well-defined margins. They are slightly hypodense to remaining part of renal parenchyma on non-enhanced images[10]. They show homogeneous enhancement after giving IV contrast. They are more homogeneous compared to RCC. Capsule can be seen around the tumour. Some show scar with low attenuation and branched appearance[11]. The scar will be non-enhancing. Central necrosis may mimic scar of RCC. Presence of central

scar without any calcification, or necrosis, may suggest oncocytoma but, there can be some overlap with small RCCs. [12-13]

ANGIO MYOLIPOMA[14]:
Unenhanced CT shows a hypoattenuating region (less than 10 HU) that strongly suggests fat in a fat-rich AML. Therefore, in the majority of fat-rich AMLs, fat detection is not a concern. However, some AMLs that are high in fat have extremely small foci of fat that are less than 10 HU in size, making it difficult to detect these hypoattenuating areas on preoperative CT. Therefore, extreme caution should be used to avoid missing a tiny focus of fat. Because thick (> 5 mm) slice thickness might not accurately depict fat attenuation, thin (5 mm) slice thickness (1.5-3 mm) should be employed. Despite the rarity, fat can still be observed in RCCs during a CT scan.

Ageandgender:

Themeanageis53.5years.Agerangedfrom3yearsto83years.25%patientswereaged51-60years,20%ofpatientswereaged61-70years,14% were aged 31-40 years, 14% were aged 71-80 years, 10% were aged41-50yearsand8%wereaged21-30yearsinourstudy.64% were males and 36% were females. This indicates that renal masseswere morecommonamongmalesinourstudy.

Anurag[15] Das et al did a study, authors wanted to know types of lesions,demographic features and diagnostic role of MDCT. 60 patients were includedin the study. Age ranged from 2 to 69 years. 51.7%of patients were aged 61-70 years. 72% patients with RCC were aged 60-69 years. Males were morecomparedtofemalesintheirstudy.

Clinicalfeatures:

74% of patients were having pain. 38% patients were not having haematuria.4%patientswerehavingfever.28% of patients had renal mass. Weight loss was seen in 88% of patients andtendernesswasnotseeninanyofthepatientsinourstudy.

Inthestudyof**Kucchal[16]A**,authorswantedtoknowtheroleofCTdiagnostic tool in determining renal masses. They did a prospective study on50patientswhohadclinicallydiagnosedrenallesion.CECTwasdoneusing 128 - slice multi detector scanner. Findings of CT scan were compared withHPEandsurgicalfindings.Themostcommonsymptomwashematuria.Hematuria was especially common in patients with malignant masses. It wasseen in patients with TCC and lymphoma and almost all patients with RCC.Weight loss was commonly seen in 75% TCC cases. Cases with abscess hadno weight loss. While, in our study, the most common symptom was weightlossfollowedbypain.

Attenuationvalues:

ThemeanNPHUinbenignlesionwas20.12anditwas91.8inmalignantlesions.Thereissignificantdifferenceinmean NPHUbetweenbenignandmalignantlesions.
ThemeanCETCHUinbenignlesionwas20.12anditwas91.8inmalignantlesions.Thereissignificantdifferenceinmean NECTHUbetweenbenignandmalignantlesions
ThemeanCETCHUinbenignlesionwas18.0anditwas103inmalignantlesions.ThereissignificantdifferenceinmeanC ETCHUbetweenbenignandmalignantlesions
ThemeanHUwasmoreinmalignantlesionsin allphasesinourstudy.

Wahba's[17] study showed that attenuation values in CMP as 80.5 HU for RCCandthemeanvaluesinNPandEPwerefoundtobe70.6HUand51.3HU. There was a significant difference between HU in CMP and EP in cases ofRCC in their study. Their attenuation values were more in malignant lesionscomparedtobenignlesions,similartoourstudy.

DiagnosticaccuracyofMDCT:

ConsideringHPEasthegoldstandard,therewere41truepositivecases,7truenegativecasesand3falsenegativecases.The sensitivityofCTindetecting malignancy was 93%, specificity was 100%, PPV was 100% NPVwas70%andoverallaccuracywas94.12%.Overall,therewere80%malignantmassesand20%benignmassesasper HPE.

Raj[18] **Yadav**etal.didastudyinassessingtheroleofMDCTinrenalmasses. Heincluded48patientswith50masses.Diagnosisconfirmationwasdonebyhpe.Bilateralmasseswereseen in2patients.31patientsweremalesand17werefemales.Malepreponderancewassimilartoourstudy. Theageofpatientsrangedfrom3to69years.92%lesionsweremalignant.Mostofthelesionsweremalignantlikeourstudy. MostcommonlesionwasRCC,likeourstudy.TCCwasseenin2patientslikeourstudy,Lymphomain 3patients,AMLin3patientsandoncocytomain1patient.Calcificationwasmorecommonlyseeninrcc.MDCTdifferen tiated malignantlesionwithsensitivityof100%, Specificity of80%, and Accuracy of 98%.While,theoverallaccuracyinourstudywas94%,sensitivitywas93%andspecificitywas100.

Limitationsofthecurrentstudy:

Inthisstudy,thesamplesizewas50,indicatingthatthestudysample was small, andthe primary limitation wasthe interpretationofresults.

Resultsforsmallstudieswerelessreliablecomparedtolargerstudies.Studieswithmoresubjectsproducenarrowconfiden ceintervals(95%to99%)andmoreaccurateresults.

V.Conclusion

In our study, 50 patients with renal masses had their CT scan results evaluated. In 82% of patients, there were malignant lesions. Benign lesions made for 18%.

When compared to the gold standard, HPE, the overall diagnostic accuracy of CT in detecting kidney cancer was 94.12%.

We came to the conclusion that the assessment of renal mass by MDCT can provide information on the amount of the lesion, its enhancement pattern, and its invasion into the nearby structures.

Using the CT scan's enhancing pattern, it is possible to differentiate between benign and malignant kidney masses, allowing the doctor to choose the best management choice.

The studywas self-sponsored

Therewerenoconflictsofinterest.

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