E-ISSN:2320-8686
P-ISSN:2321-127X
Research Article
Tomography

International Journal of Medical Research and Review

2020 Volume 8 Number 2 March-April

Publisher
MEDRESEARCH
www.medresearch.in

A study to assess the role of contrast-enhanced multiphasic, multidetector computed tomography in the evaluation of renal lesions

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DOI: https://doi.org/10.17511/ijmrr.2020.i02.07

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Aim: To assess the role of Contrast-Enhanced Multiphasic Multidetector Computed Tomography in the evaluation of renal lesions and its potential role in differentiating benign from malignant lesions. **Material and Method:** This prospective study was done in the Department of Radiodiagnosis Chirayu Medical College and Hospital Bhopal. A total of 100 patients to our department with strong clinical suspicion of renal lesions and those diagnosed by ultrasonography underwent Contrast-Enhanced Multiphasic Multidetector Computed Tomographic evaluation of abdomen using 64 Multislice Spiral CT scanner from August 2015 to July 2019. **Results:** The majority of patients presenting with renal lesions were each of the age groups <15 years and >40 years. Most of the patients were males 57%. The most common clinical complaint was renal colic 58(46%) and hematuria. The most common pathology was calculus 35(35%) second most common pathology was congenital anomalies 23(23%). The CT accuracy for detection of benign cystic lesion in this study was 94.7%, benign lesions were 92.6%and for malignant lesions was 86.6% in the present study. **Conclusion:** The accuracy of Contrast-Enhanced Multiphasic Multidetector Computed Tomography in detecting and characterizing renal lesions is high and it should be considered in the imaging workup of any patient with a renal complaint.

Keywords: Computed Tomography, Renal lesions Spiral CT

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How to Cite this Article

Khantal N, Ahirwar LP. A study to assess the role of contrast-enhanced multiphasic, multidetector computed tomography in the evaluation of renal lesions. Int J Med Res Rev. 2020;8(2):176-182.
Available From
https://ijmrr.medresearch.in/index.php/ijmrr/article/view/1165

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Manuscript Received	Review Round 1	Review Round 2	Review Round 3	Accepted
2019-12-16	2019-12-27	2020-01-04		2020-01-09

Conflict of Interest	Funding	Ethical Approval	Plagiarism X-checker	Note
No	Nil	Yes	6%	

Introduction

Contrast-enhanced multiphasic Multidetector Computed tomography plays an indispensable role in the detection and characterization of renal lesions. The detection rate of renal masses has increased in the last decades owing to the widespread use of CT and MRI [1].

The aspects of the identified renal pathologies influence the clinical and surgical decision making. Benign abnormalities such as cysts and congenital anomalies like abscess, PUJ obstruction require intervention [2].

The advent of a multidetector CT scan has enabled us to delineate the mass, detect and map the extent of venous spread, lymph nodal enlargement, and diagnose local or distant spread [3]. Malignant lesions like RCC, TCC often require active treatment [4,5].

The study is done to assess the role of Contrast-Enhanced Multiphasic Multidetector Computed Tomography in the evaluation of renal lesions and its potential role in differentiating benign from malignant lesions.

Material and Method

This prospective study was done in the Department of Radiodiagnosis Chirayu Medical College and Hospital Bhopal, Madhya Pradesh, India. A total of 100 patients to our department with strong clinical suspicion of renal lesions and those diagnosed by ultrasonography underwent Contrast-Enhanced Multiphasic Multidetector Computed Tomographic evaluation of abdomen using 64 Multislice Spiral CT scanner from August 2015 to July 2019.

Inclusion Criteria: Patients referred to the Radiodiagnosis Department with strong clinical suspicion of renal lesions. Patients already diagnosed with renal lesions by ultrasonography

Exclusion Criteria: Patients primarily with extrarenal pathology

Equipment and Technique

- CT examination was performed on a GE revolution 16 multi-slice CT scanner. This is the fourth generation rotate the only scanner with slip rings technology. The scanner has a multi-detector 64 slice configuration with a gantry rotation time of 0.33 seconds. The scanner is capable of obtaining 0.6, 1,2, 5, 8, and 10 mm Sections with a maximum range of table tilt of 0 to ± 30 degrees.
- The automatic Medrad Vistron CT pressure injector system was employed for the IV contrast administration.

Study Protocol

- A detailed history of the patient including signs and symptoms, detailed physical examination, biochemical investigations, and radiological investigations which included chest x-ray and ultrasonography of abdomen were recorded and tabulated as in the proforma.
- Written consent was taken.
- Oral contrast Telebrix (Sodium + meglumine Ioxitalamate) a water-soluble contrast agent containing iodine concentration of 350 mg/ml is given. 30 ml mixed in 1000 ml given over 1 hour. The last 200 ml is given on the gantry table.
- The patient was then placed on the gantry table in the supine position with arms placed above the head. The patient was explained to hold his/her breath on verbal instruction and to resume breathing on reinstruction. In case the patient is dyspneic or was unable to hold the breath for a reasonably long time, he/she was advised to maintain shallow breathing.
- A digital AP (anteroposterior) scout radiograph was taken from mid thorax to mid-thigh level. Factors used: 120 kvp and 35 mAs.
- A non-contrast enhanced scan is taken. The images were acquired through 2mm contiguous sections in the craniocaudal direction from 2 cm above the dome of diaphragm to pubic symphysis level with suspended respiration or shallow breathing. Reconstruction was done at 2 mm intervals.
- 100 ml water-soluble iodinated contrast (ioversol 350 mg/ml) injected IV at 3-4 ml/sec through 18-20 G i.v. cannula in the antecubital fossa using the power injector.
- Sequential phases of multiphasic imaging are done which includes.
  - Arterial phase,
  - Corticomedullary phase
  - Nephrographic phase and
  - Delayed phase.

- The images were acquired through 2mm contiguous sections in the craniocaudal direction from 2 cm above the dome of diaphragm to pubic symphysis level with suspended respiration or shallow breathing. Reconstruction was done at 2 mm intervals.

Results

Table 1 represented the distribution of cases on the basis of their age. Patients in the age group of <15 and >40 years had the maximum number of patients.

Table-1: Distribution of cases on the basis of their age.

Age group (years)	No. of Patients	%
<15	28	28
15-25	20	20
26-40	24	24
> 40	28	28
Total	100	100

Table 2 represented the distribution of cases on the basis of the sex of patients, 57% of males and 43% of females were grouped.

Table-2: Distribution of cases on the basis of their sex.

Sex	No. of cases	%
Male	57	57
Female	43	43
Total	100	100

Table 3 highlighted the distribution of cases on the basis of the clinical presentation. 46% of patients were attributed to renal colic, whereas 2% of patients were attributed to hypertension.

Table-3: Classification of cases on the basis of clinical presentation.

Clinical features	No. of cases	%
Renal colic	58	46
Fever	19	15
Hematuria	18	14
Burning micturition	12	10
Abdominal lump	11	9
Asymptomatic/ usg +ve	4	3
Hypertension	2	2
Total	122	100

Table 4 signified the classification of cases on the basis of lesions. 35% of cases were attributed with calculi whereas only 2% of cases were attributed with vascular lesions.

Table-4: Classification of cases on the basis of lesions.

	No. of Cases	%
Calculi	35	35
Congenital	23	23
Benign	13	13
Malignant	13	13
Inflammatory	9	9
Trauma	5	5
Vascular	2	2
Total	100	100

Table 5 represented the classification of cases on the basis of the congenital developmental anomalies.

A maximum number of cases were observed with PUJ obstruction (27%), whereas the minimum number of cases were observed with crossed ectopia.

Table-5: Classification of cases on the basis of congenital developmental anomalies.

	No. of cases	%
PUJ obstruction	7	27
Hypoplastic and Malrotated kidney	3	14
Ectopic kidney	3	14
Duplication and Ureterocoele	3	14
Horseshoe kidney	2	9
Agenesis	2	9
Primary megaureter	1	4
Multicystic dysplastic kidney	1	4
Crossed ectopia	1	5
Total	23	100

Table 6 highlighted the classification of cases on the basis of the presence of calculi.

A maximum number of cases were observed with calculus (78%), whereas non-calculus cases were 22%.

Table-6: Classification of cases on the basis of the presence of calculi.

Obstructive pathologies	No. of cases	%
Calculus	35	78
Non-calculus	10	22
Total	45	100

Table 7 represented the classification of cases on the basis of inflammatory lesions.

A maximum number of cases were observed with Pyelonephritis (45%), whereas 22% of cases were observed with renal TB.

Table -7: Classification of cases on the basis of inflammatory lesions

	No. of cases	%
Pyelonephritis	4	45
Renal abscess	3	33
Renal TB	2	22
Total	9	100

Table 8 represented the classification of cases on the basis of cystic lesions.

The maximum number of cases was observed with a Simple cyst (32%), whereas 10% of cases were observed with the complex cyst.

Table-8: Classification of cases on the basis of cystic lesions.

	CT Features	No. of Cases	%
Simple cyst	Homogenous, hu 0 -20, no enhancement smooth thin wall	6	32
Abscess	Thick wall, hypodense fluid collection, perinephric stranding, int contents	5	26
Urinoma	Collection around kidney + pc enhancement	3	16
PCDK	Multiple cysts in b/l kidneys, ±liver cysts	3	16
Complex cyst	Thin wall, ± septations, ±calcification, ±enhancement, ± internal contents	2	10
Total		19	100

Table 9 highlighted the classification of cases on the basis of solid lesions.

A maximum number of cases were observed with RCC (33%) whereas 10% of cases were observed in a post-traumatic hematoma.

Table-9: Classification of cases on the basis of solid lesions

	CT Features	No. of Cases	%
RCC	Hypodense/ mixed density, pc enhancement < n renal tissue, ±calcification, irregular margin, ±necrosis	7	33
TCC	Urothelium of pelvis filling defect, 40-60 hu,	3	14
Wilm's	Hypodense to mixed mass with calcification/necrosis	3	14
Angiomyolipoma	Well circumscribed solid lesions + fat of -10 hu or >	2	10
Pyelonephritis	B/l enlarged kidneys, striated nephrogram	4	19
Post traumatic hematoma	Kidney laceration, ±perinephric collection	2	10
Total		21	100

Table 10 highlighted the classification of cases on the basis of all benign lesions.

A maximum number of cases were observed with a simple cyst (22%), whereas angiomyolipoma was observed in 7%.

Table-10: Classification of cases on the basis of all benign lesions.

	No. of Cases	%
Simple cyst	6	22
Abscess	5	19
Traumatic (+urinoma)	5	19
Pyelonephritis	4	15
PCKD	3	11
Complex cyst	2	7
Angiomyolipoma	2	7
Total	27	100

Table 11 highlighted the classification of cases on the basis of malignant lesions.

A maximum number of cases were observed in cases with RCC (54%), whereas 23% of cases of TCC were observed.

Table-11: Classification of cases on the basis of malignant lesions.

	No. of Cases	%
RCC	7	54
WILM'S	3	23
TCC	3	23
Total	13	100

Discussion

In the present study, the most common age group of patients presenting with renal lesions was100 <15 years and >40 years constituting 28% of the cases. Males were the majority of patients constituting around in 57% of cases.

The most common presenting complaint was renal colic seen in 46% of the cases, followed by hematuria seen in 14% of cases.

Patients presented with overlapping symptoms in most of the cases. In the current study, the majority of patients had an abnormal size in 77 % of the cases. Normal shape, position, and contour were seen in most of the patients.

Similar results were seen by Sechel G., et al. In the current study, 23% cases were of congenital anomalies, of which PUJ obstruction was most common (7/23) followed by ectopic kidney and

Duplication anomaly (3/23). 2 cases were of horseshoe kidney and Renal agenesis each. Primary megaureter, multicystic dysplastic kidney, crossed ectopia were seen 1 case each.

Similar results were obtained by Elaine et al [6] and W C Lin et al 63. In the arterial phase, 2% of the cases showed narrowed and stenotic renal artery hence diagnosed as renal artery stenosis.

This was similar to the study done by G D Rubin et al [7] where CT angiography was 92% sensitive and 83% specific for the detection of stenosis.

45 % of the cases showed features of obstruction were seen, of which 35 cases had calculi, rest were the cases of PUJ obstruction and duplication anomalies leading to hydronephrosisOut of 35 cases of calculi, majority of the cases had severe hydronephrosis (58 %).

CT was 100% accurate in diagnosing calculi. Similar results were obtained by RC Smith et al [9] and J Chin et al [8] who had an accuracy of 99% and 97.5% respectively. Among the 40 renal lesions, solid lesions constituted the majority, which was 66% of the cases and cystic lesions constituting a minority of 44% of the cases. This is similar to the observation by Elaine et al [6].

Simple cysts were diagnosed by the presence of a well defined renal cortical lesion of fluid attenuation with no perceptible wall, internal contents, and no enhancement B A Birnbaum et al [10]. Using these criteria simple cysts (32%) were diagnosed with 100% specificity.

An abscess is well defined thick wall with internal contents and enhancement, with or without perinephric stranding. The present study had 26% of abscess in the current study. But one case of cystic RCC was wrongly diagnosed as a renal abscess with resultant accuracy of 80%.

Polycystic kidney disease was diagnosed on the presence of numerous cysts of varying sizes present in both the kidneys. Using this PCDK was diagnosed in 16% of cases. All the above lesions were classified according to Bosniak's classification. Of which majority of the cases (63 %) were of category I, 32 % were of category II, and 5 % of category III.

Similar results were obtained by Israel and Bosniak et al [11]. On the evaluation of Solid lesions, the most common finding was a post-contrast-enhanced lesion in 71% of cases and a hypodense lesion In 57% of cases.

This was followed by the presence of smooth margins in 52% of cases, necrosis was seen in 26% of cases, enlarged lymph node in 26% of cases, and calcification was seen in 20% of cases.

The renal vein or IVC thrombosis was seen in 13% of cases, pulmonary metastasis was seen in 13% of cases. Adrenal involvement was seen in 7.5% of cases. Angiomyolipoma was diagnosed by the presence of a well-defined lesion with the presence of fat. On this basis, the present study had 10 % of cases of angiomyolipoma with a specificity of 100%.

Pyelonephritis was diagnosed on the basis of bilaterally enlarged kidneys with striated nephrogram. On this basis, pyelonephritis was diagnosed in 19% of cases, with 100% accuracy. Similar results were seen in the study by Massoud Majd et al [12].

RCC was diagnosed as hypodense or mixed density lesion with post-contrast enhancement with or without calcification or necrosis. Using these criteria RCC was diagnosed. Two cases of RCC were misdiagnosed as hematoma and another as an abscess with accuracy being 77%.

Similar results were obtained by Catalano et al [13] and J Chin et al [8] who got 96% and 95% accuracy.TCC was diagnosed as a pelvicalyceal mass lesion with post-contrast enhancement. On this basis, TCC was seen in 14% of cases with 100% accuracy.

Similar results were seen by F. Millian et al [14], who got 97% accuracy in diagnosing TCC. Wilm's tumor is seen as hypo to mixed density lesion with or without calcification or necrosis. On this basis, Wilm's tumor was seen in 14% of cases with 100 % accuracy.

Similar results were seen by Fishman et al [15] who got CT accuracy as 94%. The post-traumatic hematoma was seen in 10% of cases diagnosed as renal hematoma without renal laceration or collection. One case diagnosed as hematoma turned out to be an RCC.

CT accuracy was 50%. The diagnostic accuracy for differentiating benign and malignant lesions using all the above CT criteria in this study was assessed for cystic lesions, solid lesions, and overall. The CT accuracy for cystic benign lesions in the present study was 94.7% with one false positive case.

This high accuracy was due to the presence of a

Large number of simple renal cysts. The CT accuracy for solid benign lesion detection was 87.5 %, with one false-negative case.

The CT accuracy for solid malignant lesion detection was 92.8%, due to one false positive case.

The overall accuracy of this study for benign lesions was 92.6% and for malignant lesions were 86.6% of cases.

Conclusion

The differentiation of cystic and solid lesions, benign and malignant lesions using contrast-enhanced multiphasic multidetector computed tomography in this study shows high accuracy.

What does the study add to the existing knowledge

The current study further helps in the characterization of the lesions based on morphological and enhancement characteristics.

Author's contribution

Dr. Nitin Khantal: Study design, concept, manuscript preparation

Dr. Laxman P. Ahirwar: Statistical analysis, manuscript preparation

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