Multidetector Computed Tomography in the Evaluation of Renal Masses - A Prospective Study from Ambala, India

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ABSTRACT

BACKGROUND

The advent of Multidetector Computed Tomography (MDCT) has created several important advances in the detection and characterization of renal masses due to its high accuracy, low cost, and easy availability. There is a growing need to separate benign lesions from malignant ones so as to provide an appropriate timely treatment. It can be used with contrast agents and helps in providing data during multiple phases along with the possibility of multiplanar image reconstruction anytime in the future. We wanted to study the role of CT imaging as a diagnostic modality for the evaluation of renal masses.

METHODS

This is a prospective study conducted among 50 cases, with clinically or radiologically diagnosed renal mass who were referred to our department. A detailed clinical history, thorough clinical examination, ultrasonography and multiphase - CECT using a Philips 128 - slice multi detector scanner (Ingenuity), were performed using the set - protocol followed by multiplanar reconstruction and detailed evaluation. Findings of CT scan were correlated with clinical / biopsy / surgical findings.

RESULTS

Renal cell carcinoma (RCC) was the most common renal mass in our study group (48 %) followed by renal cyst (30 %). The most common presenting symptom of RCC was haematuria (91.6 %) followed by flank pain (58.3 %). Renal cyst was a fairly common lesion with majority (93.3 %) being BOSNIAK - I category. RCC most commonly showed malignant extension via lymph nodes (83.3 %) while transitional cell cancer (TCC) most commonly spread via ureteric extension (75 %). Inferior vena cava (IVC) extension, even though seen only in a small fraction of cases (4 %), was only associated with RCC. On correlation with histopathological findings, a sensitivity of 95.8 %, specificity of 96.15 % and a diagnostic accuracy of 96 % was found, for diagnosing RCC in our study.

CONCLUSIONS

MDCT is a robust technique for detection and characterisation of renal masses. It is rapid and easily available with excellent patient compliance. MDCT has excellent sensitivity and specificity for characterisation of renal masses.

KEY WORDS

MDCT, Renal Mass, Renal Cell Carcinoma, Cyst, Attenuation, Enhancement

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BACKGROUND

The advent of Multidetector Computed Tomography has created several important advances in the detection and characterization of renal masses and is considered to be the state-of-the-art technology for the evaluation of abdomen. Due to rapid advancement in technology, there has been a substantial advancement in imaging techniques as well as their speed of acquisition. As a result, increasing number of investigations are being done on a daily basis and therefore higher number of renal masses are being discovered, intentionally or accidentally. There is a growing need to separate neoplastic masses from non-neoplastic ones and benign lesions from malignant masses. It has widely been accepted to become the preferred imaging technique for any suspected renal tumors, for the purpose of renal staging and detecting any metastases. These have become possible because of its relatively low cost, high accuracy and easy availability.¹

The wide range of radiological investigations in evaluation of the renal lesions varies from the plain abdominal radiograph, excretory urography (Intravenous Pyelography and Retrograde Urethrography / Micturating Cysto-urethrography), ultrasonography, radionuclide imaging, angiography, CT and magnetic resonance imaging (MRI).

Multidetector CT has a low image acquisition time and can be used along with a contrast agent for detecting any enhancement during any of its three phases. Another major advantage is that the data obtained can be reconstructed using complex computer based algorithms at any level at any point of time. This helps to improve the accuracy of region of interest for the purpose of measurements and in the ease of characterizing the lesion. As a result, subtle features within cystic lesions such as septations, wall thickening and nodularity can be easily evaluated. Thus, Multidetector CT is the best technique for characterization and evaluation of renal masses.²

The most common space occupying renal lesion is a simple cyst. Benign renal masses largely outnumber the malignant ones. Renal cell carcinoma is the most common tumor of the kidney. CT has largely replaced angiography as well as ultrasound in the evaluation of renal masses.

The overall diagnostic accuracy of properly performed CT for differentiating a cyst from neoplasm is extremely high. CT scan has been found to be useful for the imaging of a wide spectrum of renal diseases and masses and hence its impact on the practice of uro-radiology has been substantial. The rapid scanning time of multidetector CT permits renal imaging during the unenhanced phase as well as any of the three contrast enhanced phases: corticomedullary (20 – 40 seconds), nephrographic (80 – 90 seconds) and the excretory phase (180 – 300 seconds) as and when needed. Complete evaluation using unenhanced as well as enhanced phases is recommended as it provides a more detailed evaluation as well as characterization of any renal pathology. Unenhanced images detect calcification or fat better. On contrast CECT images, enhancement is considered to be significant if it has increased by 15 HU or more.³

This study was intended to contribute to the role of CT imaging as a diagnostic modality for the evaluation of renal masses.

METHODS

It was a prospective observational study conducted in the Department of Radiodiagnosis, Maharishi Markandeshwar Institute of Medical Sciences and Research (MMIMSR), Mullana from January 2019 to September 2020. Study was approved by ethical committee (IEC No.-1255) and was conducted on fifty patients with clinically / ultrasound diagnosed renal mass lesion.

Inclusion Criteria

1. All patients clinically suspected to have renal mass lesion.
2. All patients with diagnosed renal masses on ultrasound.

Exclusion Criteria

1. Pregnant and lactating patients
2. Any contraindication to CT
3. Patients with history of allergic reaction to contrast medium
4. Patient with deranged renal function tests (RFTs) (S. creatinine > 1.6 mg / dl)
5. Patients not willing to give consent.

A complete detailed clinical history of patient was taken regarding the chief complaints and a thorough clinical examination including local and systemic examinations were done. Relevant biochemical and blood investigations were carried out. USG was done in all cases with a convex transducer in transverse, longitudinal and other desired planes.

Multidetector Computed Tomography (MDCT) was performed as per the protocol using a Philips 128 - slice Multi detector scanner (Ingenuity). Oral contrast was used depending upon clinical situation.

Patients were made to lie in the supine position on the couch. Scout image of abdomen was taken. Low dose Plain NCCT of KUB was done at 80 KV and 250 MAS. Contrast enhanced CT was done of KUB area and slices were taken with pitch 0.765, collimation 640 x 625, 5 mm thickness, 5 mm increment at 120 KV and 300 MAS after intravenous administration of 80 - 120 ml of non - ionic contrast medium (iohexol) containing 300 mg / ml of iodine. Additional phases and delayed scans were taken when needed.

Then all the images were evaluated in axial, coronal and sagittal plane. Cystic renal masses were classified according to Bosniak classification.⁴ Findings of CT scan were correlated with clinical / biopsy / surgical findings.

Statistical Analysis

The recorded data was compiled. The sensitivity and specificity of MDCT was calculated.

RESULTS

Our study was done on a total of 50 subjects. Males were more commonly affected at 70 % (N = 35) of the cases while females made up 30 % (N = 15) of the cases. Majority of patients belonged to age group of 50 - 59 years with 30 % of cases (N = 15), followed by the age group of 70 - 79 years at 18 % (N = 9).

Out of 50 cases, there were 33 solid masses and 17 were cystic masses. Solid renal masses included RCC (24 cases), TCC (4 cases) and lymphoma (1 case) Cystic masses included cysts (15 cases) and abscesses (2 cases) Distribution of cases is shown in Table 1.

Lesion	No. of Patients	Percentage
Total cases	50	100 %
Solid masses		
RCC	24	48 %
TCC	4	8 %
AML	4	8 %
Lymphoma	1	2 %
Cystic masses		
Abscess	2	4 %
Cyst	15	30 %

Table 1. Lesion Distribution

RCC was the most common solid renal mass (Figure 1). It was most commonly diagnosed during the 5th decade of life at 41.6 % (N = 10) followed by the 7th decade at 20.8 % (N = 5). Cysts were most commonly seen in the 50 – 59 year and 80 – 89 year age groups with a prevalence of 26.6 % each with N = 4. Abscess was only seen in the age groups of 30 - 39 and 40 - 49 years with one case each in these age groups.

Figure 1. Case of RCC. Axial CECT Image Showing Heterogeneous Enhancing Mass at Midpole of Right Kidney with Central Necrotic Area.

Figure 2. Case of TCC. Axial (2A and 2B) and Coronal (2C) Images Showing Mildly Enhancing Mass at Upper and Mild Pole of Left Kidney with Extension into Renal Pelvis. Mass is Seen as Filling Defect in Renal Pelvis

30 % of the cases (N = 15) in our study were renal cysts. Out of those, 93.33 % (N = 14) were simple cysts / Bosniak - I category and only a single case was of the Bosniak - IV category which was subsequently proven to be RCC. No case of Bosniak - II or IIF or III category were found. Cysts were most commonly seen in the 50 – 59 year and 80 – 89 year age groups

with a prevalence of 26.6 % each with N = 4, followed by the 40 – 49 year age bracket.

Hematuria was mainly seen in patients with malignant masses. It was seen in 100 % cases of TCC & lymphoma and in 91.6 % cases of solid RCC. Weight loss was most frequently seen in cases of TCC in 75 % of the cases (N = 3) followed by cases of RCC at 62.5 % (N = 15). Cases who had an abscess or an Acute myeloid leukaemia (AML) showed no signs of weight loss.

Mean non contrast attenuation value of mass in RCC patients was of 36.9 HU with mean value of 73.1 HU in corticomedullary phase and 106.7 HU in nephrographic phase.

Ureteric extension was seen mostly in cases of TCC (75 %) while it was seen less frequently in cases of RCC (4.2 %). Inferior vena cava (IVC) invasion was only seen in 2 cases of RCC (8.3 %). Pulmonary deposits were seen in case of lymphoma (100 %), TCC (25 %) and RCC (20.8 %). Lymph nodal deposits were seen in cases of lymphoma (100 %), RCC (83.3 %) and TCC (75 %).

On comparison with final histopathological / biopsy diagnosis, RCC could be accurately diagnosed in nearly 96 % of the cases. One of the cases of RCC was misdiagnosed as TCC. TCC could be accurately diagnosed in 75 % of the cases (Figure 2), while one case was misdiagnosed as RCC. MDCT was found to have a sensitivity of 95.8 % to accurately diagnose RCC and a specificity of 96.15 % and diagnostic accuracy of 96 % was seen. MDCT was found to have a sensitivity of nearly 75 % to accurately diagnose TCC and a specificity of nearly 98 % (Table 2)

Lesion	No. of Patients	Sensitivity	Specificity
Total cases	50		
Solid masses			
RCC	24	95.83 %	96.15 %
TCC	4	75 %	97.83 %
AML	4	100 %	100 %
Lymphoma	1	100 %	100 %
Cystic masses			
Abscess	2	100 %	100 %
Cyst (including 1 case of cystic RCC)	15	100 %	100 %

Table 2. Sensitivity and Specificity of MDCT with Respect to Final Diagnosis

DISCUSSION

As a result of the wide availability and acceptability, there has been a substantial increase in the number of investigations that are being conducted on a daily basis and therefore, a higher number of renal masses are being detected, intentionally or accidentally. This has resulted in a growing requirement for separation of neoplastic masses from non - neoplastic ones and the benign lesions from malignant masses. MDCT has widely been accepted to become the preferred imaging technique for any suspected renal tumors, for the purpose of staging or detecting any metastatic deposits. Assuming that the lesion does not represent normal renal parenchyma (pseudotumor) or inflammatory tissue, the presence of an unequivocal lesion enhancement suggests neovascularity and neoplastic aetiology. In such instances, CT maintains its lead. MDCT scanner helps us to image kidneys or lesions in various phases of enhancement, including corticomedullary, nephrographic / excretory / delayed phases.

Our study showed that out of all the lesions studied, renal cell carcinoma made up the biggest chunk of cases, at 48 %. This was similar to other studies.⁵ Out of the study group of 50, RCC was found in 24 patients, who had an age range of 42 - 90 years with a mean age of 64.5 years.

Hematuria was the most frequent present complaint in our study (seen in 91.6 % of patients) follow by pan abdomen (58.3 %). Nearly 37 % cases were asymptomatic. This was similar to other studies.^{5,6} The second most common presenting feature was abdominal pain. Only 4 cases or 8 % of our study group had the classic triad of renal cell carcinoma (including flank pain, palpable mass and haematuria) which was comparable with the findings of Donald G. Skinner et al.⁶ who found the symptoms to be present only in 9 % of the cases. They also had hematuria as the most frequent finding at 60 % of the cases which was comparable with our study.

RCC usually presents with heterogenous exophytic renal masses. Smaller lesions may show homogeneous enhancement, however larger lesions usually show heterogeneous enhancement with areas of necrosis. Clear cell type which is the most commonly encountered histopathological variant typically shows significant enhancement. Multiple studies have been conducted over time which have repeatedly proven that nephrographic and excretory phases are far superior to the corticomedullary phase for the purpose of detection of a renal mass. Enhancement is less and sometimes equal to normal renal parenchymal in corticomedullary phase and is most pronounced in nephrographic phase.⁷ In our study, mean enhancement of mass was more pronounced in nephrographic phase.

The mean attenuation of lesion in RCC subjects was 36.9 HU in plain scan, 73.1 HU in corticomedullary phase and 10.6.7 HU in nephrographic phase. This helps us ascertain the finding that the nephrographic phase is more reliable than the corticomedullary phase to help detect renal mass. Renal veins could be better visualized during the corticomedullary phase of the scan. IVC showed flow artefact during the corticomedullary phase due to mixing of unopacified blood from caudal part of inferior vena cava along with the contrast opacified enhanced blood from renal veins, therefore IVC was better seen in the nephrographic phase. These results were similar to other studies.^{8,9}

TCC shows less enhancement compared to TCC. They are centred in the renal pelvis region and ever large masses may present with preserved renal outline.⁹ RCC most commonly showed lymph nodal spread (83.3 %) while ureteric extension was mostly associated with TCC (75 %) while a single case of lymph showed pulmonary deposits. These findings were similar to previous studies.^{5,8}

Renal cysts consisted of 30 % of our study group with an age range of 38 - 85 years and an average size of 6.1 cm. Bosniak classification is widely used for the classification of cystic renal lesions.⁴

Out of all the simple renal cysts, 93.33 % were simple cysts / BOSNIAK - I category and only a single case was of the BOSNIAK - IV category. Bosniak classification is based on the CT enhancement characteristics of cystic lesions. Any nodular enhancing areas within the renal cyst are suspicious for malignancy and are classified as Bosniak type IV.

In our study, two cases of renal abscesses were encountered. CT is the most accurate imaging modality for

correct diagnosis.¹⁰ Renal abscesses presented with peripherally enhancing cystic renal masses. The enhancement was usually smooth unlike malignant necrotic tumors. The affected kidney usually showed associated changes of pyelonephritis or nephronias. MDCT is excellent of multiplanar depiction of the extent of abscesses. It also accurately depicts any complications like rupture and associated perinephric, hepatic or psoas abscesses. This information is critical for treatment planning.

Renal angiomyolipomas are the most common benign renal masses. They present with renal masses with macroscopic fat; therefore, diagnosis is usually easy. Very rarely macroscopic fat may be seen in RCC. On the other hand, some angioliipomas may be fat poor and only show microscopic fat. Follow up may be necessary in equivocal cases.¹¹

A single case of renal lymphoma was encountered in our study. Lymphoma is a multisystem disorder and MDCT is the imaging modality of choice for evaluation of its extent.¹² Renal lymphoma can be present with single or multiple renal masses, perinephric soft tissue mass and bulky retroperitoneal lymphadenopathy. Deposits may also be seen in lungs, liver and spleen.

CONCLUSIONS

MDCT is a robust and rapid imaging modality for detection and characterization of renal masses. It has high sensitivity and specificity for differentiating RCC from TCC.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.

Financial or other competing interests: None.

Disclosure forms provided by the authors are available with the full text of this article at jemds.com.

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