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ROLE OF COMPUTED TOMOGRAPHY IN ASSESSMENT OF SOLID AND CYSTIC RENAL MASS

Radio-Diagnosis

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ABSTRACT

The widespread use of cross-sectional imaging techniques has led to a significant increase in the detection of small, often asymptomatic renal masses. Over 50% of renal cell carcinomas (RCCs) are discovered incidentally through noninvasive imaging methods. Effective management of these renal masses requires a thorough understanding of imaging modalities to ensure accurate diagnosis, staging, and treatment planning. This review examines the role of computed tomography (CT), in the evaluation of renal masses.

KEYWORDS

Renal neoplasms, Renal cell carcinoma, Multimodality Ct scan

INTRODUCTION

Computed Tomography (CT) scans are a cornerstone in the evaluation of renal masses. With the increased use of cross-sectional imaging, incidental detection of renal masses has become common. These masses range from benign tumors to malignant renal cell carcinomas (RCCs) with varying degrees of aggressiveness. CT imaging plays a critical role in differentiating between these conditions, guiding management decisions, and monitoring treatment outcomes.

Computed tomography is very important tool for assessment of renal masses for diagnostic and preoperative evaluation.

The study carried out to understand the role of CT imaging as an accurate modality to evaluate the renal masses.

To study in detail the morphology of renal mass – number, site, extent,shape, margin,calcification, density and enhancement pattern and characterization tem in benign and malignant lesions.

Use of BOSNAIK classification system for cystic renal mass for prediction of risk of malignancy and suggestion for follow up and treatment.

Renal masses are found in all age groups, right from the commonly occurring Wilm's tumor in children, renal cell carcinoma in adults, to the rarer multilocular cystic nephroma, which is found in both the age groups, although with different sex predilections.

Imaging plays a key role in evaluating these lesions. While the commonest cystic renal lesion is a cortical cyst which includes simple cyst and complicated cyst, the other cystic renal lesions include polycystic renal disease, multicystic dysplastic kidney, multilocular cystic nephroma, renal cysts in hydatid disease, renal cysts associated with systemic diseases like Tuberous sclerosis complex and von Hippel Lindau disease.

Renal tumours are the eight most common malignancy, account for approximately 3% of newly diagnosed cancers. The majority of tumors (85% to 90%) are renal parenchymal lesions, generally renal cell carcinoma in adults.1 Others renal tumors in adults include adenoma, oncocytoma, transitional and squamous cell carcinoma of the renal pelvis, lymphoma and metastases. Rare renal neoplasms which are of epithelial origin include small cell carcinoma and juxtaglomerular cell tumour, while those of mesenchymal origin are leiomyoma, hemangioma, lipoma, angiosarcoma and osteosarcoma. In children, renal neoplasms constitute about 55% of pediatric abdominal masses. Approximately 87% of solid renal masses are wilm's tumours, clear cell sarcomas (6%), rhabdoid tumours (2%), mesoblastic nephromas (2%), lymphomas (0.5%) and renal cell carcinomas.

- CT scanning is now well established as the current most satisfactory modality for diagnosis and staging. CT can distinguish between the perirenal fascia and fat layers and hence differentiate stage I from II tumours, which is of vital significance when only local resection is planned.
- CT is also more accurate for diagnosing Stage III tumours (except in the retro hepatic portion of IVC). Direct spread in the abdominal well visualized.
- CT scanning is also appropriate for detecting blood borne metastases to liver, lung and bone. The lungs, liver, lumbar spine and pelvis may be scanned at the same time as the renal examination.
- The newest technique of Spiral CT may greatly increase the accuracy for detecting small renal neoplasms and staging them as it does not miss any volume due to respiratory movements.
- It may be possible to assess and follow malignant potential of these small renal tumors based on the enhancement pattern. In general, a CT scan serves as a single step investigation and provides most significant amount of information with regard to the size and location of the lesion, perinephric spread, venous involvement, degree of adenopathy, adjacent organ infiltration and distant blood borne metastases. Study aimed to assess the role of CT (Computed Tomography scan) in the characterization of renal masses.

MATERIALS AND METHOD

- The study was conducted by taking 30 patients wit clinical or radiological diagnosed renal masses are referred to our department.
- A detailed clinical history , examination and MDCT-CECT **Philips256 slice** were performed using the set protocol followed by multiplaner reconstruction and evaluation.
- Findings were co-related clinically and with biopsy or surgery follow up.
- CT protocol for renal masses composed of

A precontrast phase (obtained before the administration of contrast material), to determine the HU of homogenous renal mass or masses containing macroscopic fat (characteristic for angiomyolipoma);
A corticomedullary phase (40–70 s), useful to differentiate the RCC subtypes;
Nephrographic phase (100–120 s after the contrast administration), in which there is the maximum and homogeneous enhancement of renal parenchyma, allowing detection of small hypodense masses;
An excretory phase (7–10 min), recommended in preprocedural planning and in order to distinguish urothelial carcinoma from RCC.

0-10 HU Nonenhancement hemorrhagic cst 10-20 HU Equivocal >20HU Definite enhancement

Benign lesions

Angiomyolipomas

- AMLs are benign neoplasms of mesenchymal origin, composed of aberrant blood vessels, mature adipose tissue, and smooth muscle.
- Typically incidentally found on images, they have female preponderance (1:2, M/F).
- They presents sporadically and also found with genetic disorder-Tuberous sclerosis.
- They can be distinguished into two distinct epidemiological forms:

- The most specific feature for the diagnosis is fatty (i.e., adypocytes) content in it by CT imaging with of fat attenuation (less than -20HU).

Figure:

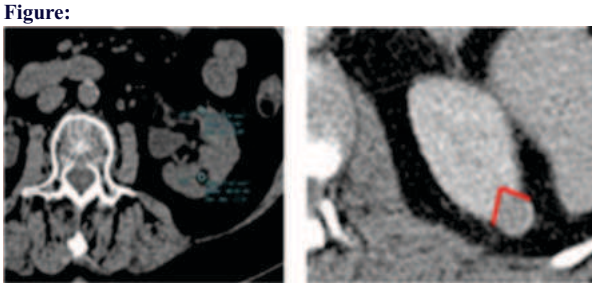

Figure 1: Shows fat density lesion in the cortex of the mid pole of left kidney trength of rubberized concrete can be improve when fine aggregate was fully replaced by fine crumb rubber. He also indicated that if the rubberParticles have rougher surface or given a pretreatment, the better and improved bonding may develop with the surrounding matrix, and that may result in higher compressive strength.

Oncocytoma is also common and is composed of oncocytes (polygonal or round cells, with moderate to abundant granular cytoplasm) surrounded by thin capillaries and stroma.

- Patients are usually asymptomatic, more frequently men (2:1, M/F), and having a mean age of 65 years at diagnosis.
- Oncotoma are smaller in size <4cm and unifocal.However sometimes they present as multifocal and bilateral mostly with hereditary syndromes such as familiar oncocytosis and Birt–Hogg–Dubé syndrome
- In CT, they appear as sharply demarcated lesions with uniform enhancement and often have a central scar .They are hypervascular tumour.
- It is difficult to distinguish RCC from oncocytoma as both are hypervascular and oncocytoma may present with necrosis and haemorrhage while RCC can also sow central scar.
- One way we can distinguish is with enhancement pattern in the corticomedullary phase seems to be useful for differentiating oncocytoma from clear cell RCC, since oncocytoma appears isodense to normal renal cortex in corticomedullary phase while clear cell RCC appears hypodense
- Another way is with the help of pseudo capsule.

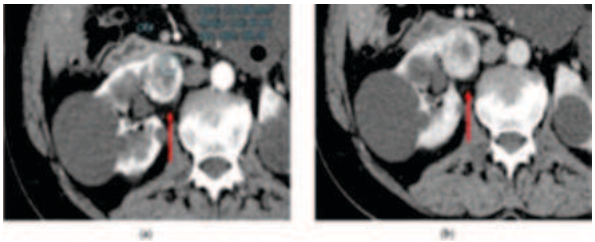

Figure 2 a, b: There is isodense lesion in corticomedullary phase and which enhancing in nephrogenic phase noted in renal cortex

Malignant lesions

- **Renal cell carcinoma(Clear cell type)**

Most of renal tumors measuring 4 cm or smaller are renal cell carcinomas, with the clear cell subtype accounting for the majority of cases (75–80%); ccRCC originates from the cortex, from the proximal tubule.

- Noncontrast CT scans can present cystic components, hemorrhage, and calcifications. In contrast-enhanced CT, ccRCC enhances vividly, with the maximum of intensity in the corticomedullary phase (with an interval between 116.5 and 133.5 HU).
- While chromophobe and papillary lesions both reach their highest enhancement during the nephrographic phase, as opposed to ccRCC, which reaches its maximal enhancement during the corticomedullary phase

Papillary RCC

- Papillary RCC is the second most frequent RCC originates from proximal tubule and includes types I and II. Type I (basophilic) is associated with a better prognosis, usually it is sporadic but could be associated with MEN syndrome in small cases. Type II (eosinophilc) is less common and, on the contrary, has a worse prognosis . These two types cannot be differentiated on imaging.
- pRCC is usually hypovascular and in noncontrast CT it may present with hyperdense foci (measuring from 45 to 90 HU), which are circumscribed hemorrhagic spots. pRCC presents progressive enhancement and reaches the maximum attenuation in nephrographic phase.
- The mean enhancement of ccRCC is significantly greater compared to pRCC in every phase .
- J. Ruppert-Kohlmay et al. found that tumor attenuation smaller than 100 HU in the corticomedullary phase, was 95.7% specific for papillary RCCs, compared to ccRCC .

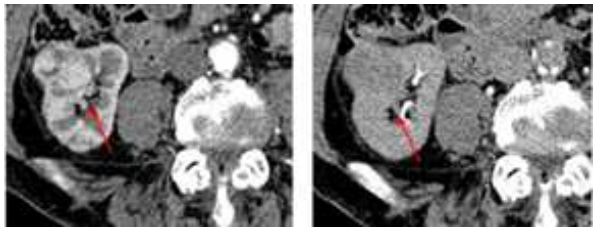

Figure 3: There is evidence of enhancement in corticomedullary phase and washout in delayed phase

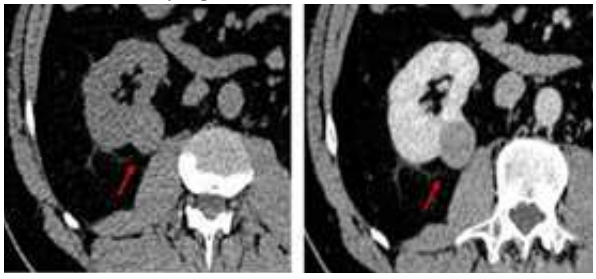

Figure 4: there is hypodense lesion in the renal cortex which shows minimal enhancement on contrast administration

Chromophobe RCC

- ChrRCCs represent 4–8% of RCCs and originate from collecting-duct intercalated cells. It is the RCC subtype associated with the best prognosis, a 5-year survival rate around 90% . ChRCC can be seen in patients with Birt–Hogg–Dubé syndrome. These patients have small papular skin lesions called fibrofolliculomas—lung cysts with spontaneous pneumothorax.
- ChrRCC shows more commonly homogeneous–moderate enhancement, lower compared to ccRCC, with the attenuation peak in the nephrographic phase. Based on the enhancement threshold, it is easily differentiated from ccRCC.
- ChRCC at the time of diagnosis generally has a diameter >4 cm and may present calcifications and could occasionally contain a central scar. Typically, it has a homogeneous enhancement and a homogeneous cut surface without hemorrhage or necrosis.

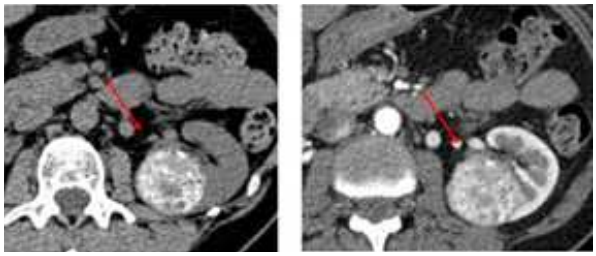

Figure 5: shows multiple macroscopic calcifications in a noncontrast CT;shows that the mass is hypovascular in the arterial phase. The lesion is histologically confirmed as chRCC.

Transitional cell carcinoma

- Transitional cell carcinoma (TCC), also known as urothelial cell carcinoma (UCC), arises from the epithelial cells lining the urinary tract. It is a rare tumor (less than 5% of renal tumors) and usually arises from the renal pelvis as an intraluminal mass of the renal-collecting system.
- The urographic phase is crucial to diagnose TCC: it is a typical filling defect that can expand and compress renal sinus fat. It may

present as focal or diffuse mural thickening or as focally obstructed calices. Both TCC and ccRCC can show early enhancement and early washout, but normally RCC reaches higher HU values.

- Since, even in small TCC, hydronephrosis is the most frequent finding and hydro ureter can often be seen to the point of obstruction, this feature can be useful to differentiate TCC from RCC. A small renal RCC tumor is quite unlikely to cause hydronephrosis

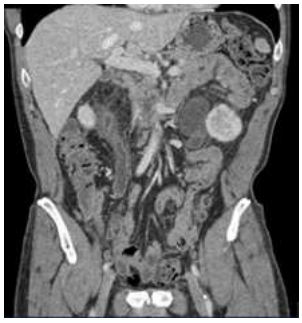

Figure 6: There is evidence of irregularly enhancing mucosal wall thickening causing luminal narrowing noed involving right mid ureter

Lymphoma

- The genitourinary system is commonly affected by extranodal spread of lymphoma in which the kidneys are the most commonly involved organ . Primary renal lymphoma, that is, the involvement of the kidney without systemic disease, is rare (1% of cases of extranodal lymphoma). Secondary lymphoma is much more common and originates from the direct spread of retroperitoneal adenopathy or hematogenous spread from systemic disease.
- Imaging findings are unspecific, even if six major patterns have been described: multiple lesions, solitary lesion, direct extension from retroperitoneal adenopathy, perinephric disease, nephromegaly, and renal sinus involvement.

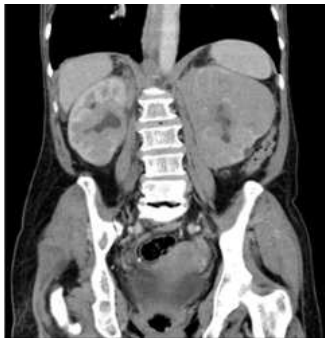

Figure 7: There is evidence of large ill-defined hypodense homogenously enhancing lesion noted in bilateral kidneys. Both kidneys appears bulky.

Renal Metastases

Primary malignancies that most commonly metastasize to the kidney reflect the pattern of cancer occurrence in the general population, with lung, breast, gastrointestinal tumors, and melanoma

Cystic renal masses

Most common is simple cystic mass.

WE classify the cystic lesion based on BOSNAIK classification.

This classification aids in characterization of lesion and elps to know the nature of the lesion wheteher benign or malignant and helps deciding follow up plan and management.

Bosniak stage	Risk of malignancy (%)	Features
I	0	Thin wall without septa or solid components. No internal enhancement.
II	0	Few (≤3) thin septa. It may show minimal enhancement of the septa. Hyperintense on T1 without enhancement.
IIF	5	Multiple (>3) thin septa. Smooth mild thickening (3 mm) of the wall or septa. It may contain minimal enhancement of the septa.
III	50	Thickened (>3 mm) wall or septa with enhancement. Irregular wall or septa with enhancement.
IV	90	Soft tissue enhancing mass independent from the wall.

DISCUSSION

- The aim of our study is to give the reader a useful framework to assist in correct diagnosis with CT imaging, and to reduce the number of renal biopsies leading to the possibility of seeding.
- MDCT helps to diagnose benign and malignant lesion by characterization of lesion type in terms of morphology, attenuation,density and spread.
- My study showed RCC was most commonly encountered.
- Out of classic triad of RCC (flank pain, palpable mass, haematuria)-
- Haematuria was the most common symptom.
- RCC presented as heterogenous exophytic mass with areas necrosis with mean attenuation of lesion in RCC was +36 HU in plain, +73.2HU in corticomedullary phase and +106HU in nephrogenic phase.
- Nephrogenic phase is more reliable than corticomedullary phase for mass detection and IVC spread.
- TCC showed low enhancement pattern and pelvic spread, while RCC showed lymphatic spread.
- Out of all cystic mass most of them were BOSNAIK-I category.
- Renal angiomyolipoma most common benign solid mass and shows fat attenuation.
- Renal lymphoma can be present as single or multiple masses,perinephric mass and reteroperitoneal lymphadenopathy.
- Hypovascular solid lesions are strongly malignant- chromophobe RCC and Papillary RCC both are hypovacular and they show delayed and prolonged enhancement with a peak in nephrographic phase, occasionally in the excretory phase (pRCC poorly vascularized).
- ChRCC usually presents as a large lesion and can show macroscopic calcifications, while pRCC is mostly a small renal mass that may show hyperdense
- Macroscopic (extracellular) fat in the mass is highly typical of AML.
- The presence of an angular interface, indeed, is reported as a sign of benignity, which could be detected using CT, and is typical of lipid-poor AMLs.
- When considering hyper vascular lesions, both ccRCC and oncocytoma show the same contrast-enhancement pattern. However RCC has pseudocapsule and shows prolonged enhancement as compared to oncocytoma.
- CT is also the cornerstone for differential diagnosis of oncocytoma and chRCC, which may show histologically the same traits, characterized by eosinophilic cells. This is a typical circumstance of when biopsy could not be diriment, but instead CT imaging is. In fact, they show opposite contrast enhancement patterns: oncocytoma is hypervascular and chRCC is hypovascular.
- Presence of fat and calcification both at the same time points towards malignancy.
- Currently, histology, after imaging-guided biopsy, is crucial to discriminate between oncocytoma and hyper vascular ccRCC; thus, another future challenge for radiologists will be to distinguish one from the other by only relying on CT imaging.

RESULTS

- Renal cyst was fairly common with BOSNAIK-I category was most common.
- With the help of morphological features and enhancement pattern we can differentiate different types of solid benign and malignant masses.
- Renal cell carcinoma was more common and in that subtype clear cell RCC was predominately common.
- Majority were male patients with age group of 59-68 years presenting with complain of hematuria being most common and second most being abdominal pain.
- RCC showed metastasis and also associated with IVC extension in few cases.
- Transitional cell carcinoma most commonly spread via ureteric extension.

CONCLUSION

- MDCT is rapid and easily available with patient compliant tool for evaluation of renal masses.
- Ct scan is accurate in diagnosis, staging and preoperative evaluation for renal mass with high diagnostic accuracy.
- BOSNAIK CLASSIFICATION is useful for characterization of cystic mass and helps predict risk of malignancy and a guide in management.

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