BENHA MEDICAL JOURNAL bmj
Print ISSN 1110-208X
Online ISSN 2357-0016

Original article

The Role of Multidetector Computed Tomography (MDCT) and Magnetic Resonance Imaging (MRI) in Diagnosis of Renal Cell Carcinoma

Omima M. Nagdy [a], Medhat M. Refaat [a], Hany H. Lotfy [b], Ahmed S. Mohamed [a]

[a] Department of radiology, Benha faculty of medicine, Benha University, Egypt.
[b] Department of radiology, Almaadi Armed Forces compound , Military Medical Academy , Egypt.

Correspondence to:
Omima M. Nagdy, Department of radiology, Benha faculty of medicine, Benha University, Egypt.

Email:

om6200087@gmail.com

Received: 19 July 2022

Accepted: 13 August 2022

Abstract

Background: Renal cell carcinoma (RCC) is the most common adult renal epithelial cancer, accounting for more than 90% of all renal malignancies . RCC is the most lethal of all urologic cancers . There is continued global increase in the incidence of RCC, partly due to early diagnosis with cross-sectional imaging modalities. **Purpose** : was the assessment of the role of imaging techniques (multidetector CT and MRI) in detection, diagnosis, staging of renal cell carcinoma in correlation with pathological assessment. **Methods:** Our study included 30 patients who were referred to the radiology departments in armed forces hospitals from various departments (urology, surgery and oncology) for radiological evaluations. The data were collected in the period between February 2018 and February 2021. **Results:** In our study 6 patients have distant deposits , 4 to the lung , one to the pleura and the lung and one to the lumbar spine . CT is more practical to evaluate chest and to detecting pulmonary nodules . MRI is more practical to evaluate bone deposits. MRI show marked accuracy and better resolution in detection and characterization of additional septa, thickening of the wall and/or septa, or enhancement. Yet in our study usage of MRI in evaluation of two complex renal cystic masses not lead to an upgraded Bosniak cyst classification. **Conclusion**: the advent of MDCT and MRI machines and techniques led to better detection , earlier diagnosis , and proper evaluation of RCC.

Keywords: multidetector computed tomography ; magnetic resonance imaging ; renal cell carcinoma.

Introduction

Renal cell carcinoma (RCC) is the most common malignant tumor of the kidney. It accounts for 90-92 % of adult renal tumors, and 2-3 % of all adult malignancies [(1)].

About half of all RCC are discovered as an incidental finding on cross-sectional imaging studies; computed tomography (CT), ultrasonography (US), and magnetic resonance imaging (MRI) [(2)].

Adequate preoperative radiologic assessment provides the treating physician with information critical in determining the sequence of treatments, role of nephron-sparing surgery, surgical approach, the use of ablative techniques, and timing of systemic therapy for metastatic disease [(3)].

The goals of radiologic imaging are to detect and stage the primary tumor, evaluating the possibility of regional nodal or abdominal visceral metastases , such as to the adrenal glands, liver, pancreas, and contralateral kidney, delineation of vascular anatomy and evaluation of venous thrombosis [(4)].

Recently In addition to morphologic imaging features, the dynamic contrast agent–enhancement features of clear cell, papillary, and chromophobe RCC may assist in imaging diagnosis. By using dynamic contrast-enhanced computed tomography (CT) and dynamic contrast-enhanced MR imaging [(5)] .

Diffusion-weighted MR Imaging could add supportive information for differentiation of malignant from benign masses particularly in evaluating such patients who enhanced imaging techniques are contraindicated [(6)] .

The aim of this study was the assessment of the role of imaging techniques (multidetector CT and MRI) in detection, diagnosis, staging of renal cell carcinoma in correlation with pathological assessment.

Patients and methods

The present prospective study included 30 patients who were referred to the radiology departments in armed forces hospitals from various departments (urology , surgery and oncology) for radiological evaluations.

The data were collected in the period between February 2018 and February 2021.

This study gained the approval of the local ethical committee of Benha Faculty of Medicine

These patients were 17 males and 13 females with their age ranging between 45 years and 75 years.

Inclusion criteria were obtained and all patients complaining of abdominal swelling, hematuria, dysuria, loin pain, and others as chronic renal disease and renal failure) were included in this study as inclusion criteria for performing imaging by CT & MRI . Physical examination was done.

Exclusion criteria were detected for patients with no any urinary symptoms , normal urine analysis (no hematuria) & normal ultrasound consider as exclusion criteria for imaging as renal cell carcinoma .

A multiphasic renal CT examination of the abdomen using a multidetectors CT scanner was obtained for all patients.

Renal MRI imaging including basic sequences T1 WI and T2WI in addition to enhanced dynamic sequences and diffusion WI sequence were obtained for all patients.

All histopathological reports of all patients were collected and evaluated either by surgical specimen or by tissue biopsy.

CT PROTOCOL

All patient underwent multiphasic CT scanning for the kidney and urinary tract following a preset scanning protocol that included unenhanced , corticomedullary phase, nephrographic phase and excretory phase .

The examination was performed with sixty four and sixteen channels multi-detector row CT scanner (Light Speed GE medical system and TOSHIBA Medical system, Activion respectively)

Patients were lying supine in the feet first position at complete rest . Hands were placed behind head . All instructions were given to the patient regarding table movements, voice messages , sensation of contrast injection, timing and manner of breath holding .

Unenhanced CT of the abdomen and pelvis down to the iliac crest was performed first.

An intravenous injection of 100–150 mL of nonionic iodine contrast dosed to weight about 2 ml / kg . using A power automatic pump injector at a rate of 3-5 mL per second, a bolus tracking algorithm was used to determine the onset of imaging (smart preparation in GE or sure start in TOSHIBA). The scan performed during breath holding . a region of interest (ROI) was placed in the thoracoabdominal aorta junction, with a trigger set to begin at 150 HU. Corticomedullary phase imaging occurred 40 seconds after the threshold level of 150 HU was reached. Nephrographic phase imaging occurred 90 seconds after the threshold level of 150 HU was reached. Excretory phase imaging occurred 4- 8 minutes after the threshold level of 150 HU was reached.

CT parameters: 120 kVp, tube current 20-300 mA, and a section thickness interval of 3–5 mm .

MRI PROTOCOL

All patient underwent MRI imaging including basic sequences T1 WI and T2WI in addition to enhanced dynamic sequences and Diffusion WI sequence.

The examination was performed with 3.0 Tesla DISCOVERY 750 and Optima MR 1.5 Tesla GE medical system .

Patients were lying supine with the feet towards the bore using torso phase array body coil. The coil is secured in place with a tight Velcro strap. Respiratory bellows are placed around the abdomen . When possible the scan

performed within one breath-hold. The scan performed during expiration. Using respiratory triggering technique.

All instructions were given to the patient regarding MRI noisy sound , voice messages, timing and manner of breath holding.

Using protocol MRI system consists of the following sequences:

Coronal T2-WI single-shot turbo spin echo sequence (TR 2000 , TE 120 ms, flip angle 90°, breath-hold)

Axial T2-WI turbo spin echo sequence with and without fat suppression (TR 2000 ms, TE 100 ms, flip angle 90°, respiratory triggering).

Axial T1-WI gradient echo sequence, in-phase and opposed-phase as a dual-echo sequence. (TR 180 ms, TE 2.3 ms/4.6 ms, flip angle 90°, breath-hold).

T1-WI gradient echo sequence for dynamic imaging (TR 130 ms, TE 1.0 ms, flip angle 90°), before and after intravenous gadolinium contrast, immediately followed by three breath-hold periods. In this way pre- contrast and post-contrast images in corticomedullary and nephrographic phases are obtained. Gadolinium was injected via IV at a rate of 2 mL/s using a power injector followed by a 20-mL saline flush. The dose of gadolinium was 0.1 mmol/kg of body weight

Diffusion WI : The acquisition was performed during free breathing without ECG or respiratory gating using a maximum b value of 400 and 800 s/mm2.

CT and MRI Analysis:

On the basis of the appearance of normal renal parenchyma, images from these protocols were classified as unenhanced if there was no contrast material administration, corticomedullary if the renal cortex but not the medulla enhanced in a ribbon like pattern, nephrographic if the cortex and medulla enhanced uniformly, or excretory if the concentrated contrast material was excreted in the renal pelvis and ureters.

After the prior phases. Images were sent to our picture archiving and communication system for interpretation supplemented by analysis on a dedicated three-dimensional workstation.

Multiplanar display techniques are used to improve confidence in identifying small masses that deform the renal contour more substantially or exclusively in the coronal plane. For 2D and 3D interpretation.

Data interpretation

After confirmation of presence of renal mass, certain information was then fulfilled , they include renal mass shape, size, locations, depth, CT density of tumor, MRI signal of the tumor, pattern of tumor enhancement, MRI Diffusion pattern, tumor extension, perinephric spread of the tumor, invasion of ipsilateral adrenal gland, venous spread of tumor, collecting system invasion, surrounding organs invasion , regional metastatic lymph nodes, distant metastasis .

Staging of RCC depended on previously collected data. TNM score was used in this study.

Statistical Analysis:

Data were collected, tabulated and analyzed using IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp

Results

The RCC masses presented in different size which is divided into 4 categories corresponding to TNM staging system either below 4 cm or equal, between 4 cm to 7 cm , between 7 cm to 10 cm , and above 10 cm to facilitate TNM staging application **Table (1)**.

In our study 28 solid renal masses located in between 20 – 70 HUs ,two cystic masses have less attenuation values .

RCC associated with tumor calcifications seen in 2 patients (7%)

In our study 28 solid masses located in the danger zone between 20 – 70 HUs, two cystic masses have less attenuation values.

In our study renal solid masses represent 28 patients (93%) , cystic complex RCCs represent two cases (7%).

Degree of enhancement of solid renal masses categorized into prominent enhancement , moderate enhancement , minimally or noenhancement .

Pattern of enhancement also divided into homogenous or heterogeneous enhancement. Degree of enhancement evaluated in early cortico-medullary and nephrographic phases .

In our study 25 renal solid masses represent about 89% of solid masses show prominent or moderate degree of enhancement .

In our study 3 renal solid masses represent about 11 % of solid masses show minimal or no apparent degree of enhancement .

In our study 23 form 25 renal solid masses which show prominent or moderate enhanced pattern show heterogeneous pattern of enhancement **Table (2)**.

In our study all markedly or prominent enhanced renal masses have proved to be clear type RCC .

In our study all minimally enhanced renal solid masses have proved to be papillary type RCC .

In our study all heterogenous prominent enhanced renal masses have proved to be clear type RCC .

In our study these two homogenous moderate enhanced renal solid masses have proved to be clear type RCC .

In our study we have no any case of chromophobic RCC **Table (3)**.

RCC masses with renal vein and IVC tumoral thrombosis extension categorized into RCC masses with no renal vein invasion , renal masses with renal vein tumoral thrombosis , renal masses with thrombosis extending to IVC but below the diaphragm, and renal masses with thrombosis extending to IVC above the diaphragm .

In our study 7 cases show tumoral renal vein thrombosis represent about 23% , two of them extending to IVC represent about 6 %.

In our study no any thrombosis extending above diaphragm .

In our study MRI have more better resolution and lineation of IVC and renal vein as well as more accurate estimation of enhanced tumoral thrombosis , yet MDCT

64 with coronal and sagittal reconstruction notmiss any of the thrombosis in our study **Table (4)**.

In our study 5 masses show associated enlarged regional LNs representabout 17 % CT and MRI with contrast show the same accuracy in detection and evaluation of enhancement pattern of the lymph nodes .

RCC masses associated with distant metastasis seen in 6 cases (20%)

RCC metastasis seen in lungs , pleura mediastinum , and bones .

In our study 6 patients have distant deposits , 4 to the lung , one to the pleura and the lung and one to the lumbar spine .
CT is more practical to evaluate chest and to detecting pulmonarynodules .
MRI is more practical to evaluate bone deposits **(table 5)**.

Case presentation

History: male patient 70 years old, incidental discover large renal mass by US

Right kidney shows large mainly cortical solid mass , occupying anterior lateral aspect of right lower pole , measuring about 12 x7x7 cm at AP , Craniocaudal, and transverse diameters respectively , no fat contents , no calcifications , mass show avid early heterogeneous enhancement at corticomedullary phase after contrast administration at triphasic CT and Dynamic MRI study with rapid wash out through out consequent phases , mass show low signal on T1 and high signalon T2, evidence of restricted Diffusion , no regional enlarged LNs , patent renal veins as well as IVC , obliterated perinepheric fat anteriorly with no separable cleavage line between mass and the liver , no collecting system invasion , bilateral multiple simple renal cortical cysts seen , no other solid masses seen , no evidence of any distant metastasis .Imaging criteria of renal cell carcinoma , clear cell type , patient underwent right nephrectomy and histopathology is confirmed to be clear cell type .

Diagnosis: Right renal cell carcinoma T3a N0 M0, clear cell type **(Figure 1- 4)**

Imaging findings:

Table (1) : Different Size of renal masses

Size of the tumour	Number of patients	Percentages
< 4 cm	7	23%
4cm to 7 cm	10	33%
7 cm to 10 cm	8	27%
➢ **10 cm**	5	17%

Table (2) : Different pattern of enhancement of solid RCC

Degree enhancement ofsolid masses	Pattern of enhancement	Number of patients	Percentages
Marked or moderate degree of enhancement	Heterogeneous	23	82%
	Homogenous	2	7%
No apparently or minimally enhanced masses	Homogenous	3	11%

Table (3) : Renal cell carcinoma subtypes **.**

Subtypes	Number of patients	Percentage
Clear RCC	25	83%
Papillary RCC	3	10%
Multilocular RCC	2	7%

Table (4): Renal veins and IVC tumoral thrombosis

Venous thrombosis	Number of patients	Percentages
No venous thrombosis	23	77%
Renal vein thrombosis only	5	17%
IVC extension below diaphragm	2	6%
IVC extension above diaphragm	0	0%

TNM staging of RCC

(table 5)

Tumor (T)	Number of patients	Percentage
T1 a	7	23%
T1 b	7	23%
T2a	4	14%
T2b	3	10%
T3a	3	10%
T3b	3	10%
T3C	1	3%
T4	2	7%
Lymph nodes (N)	Number of patients	Percentage
N0	25	83%
N1	5	17%
Distant metastasis (M)	Number of patients	Percentage
M0	24	80%
M1	6	20%

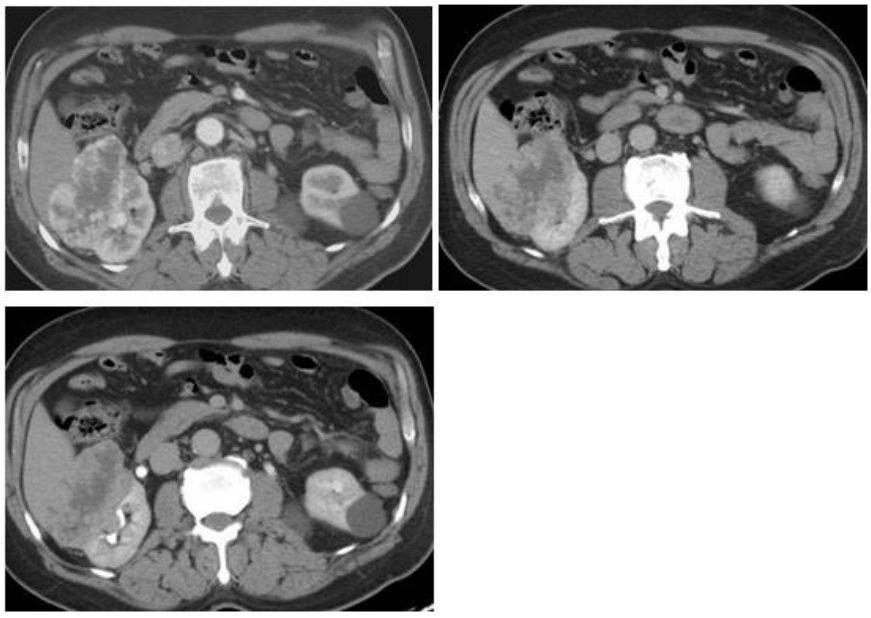

Fig (1): axial images of tripahsic CT(corticomedullary , nephrographic and delayed phases) show right large heterogeneous enhanced solid mass , early avid enhanced at cortico-medullary phase and wash out atdelayed phase .

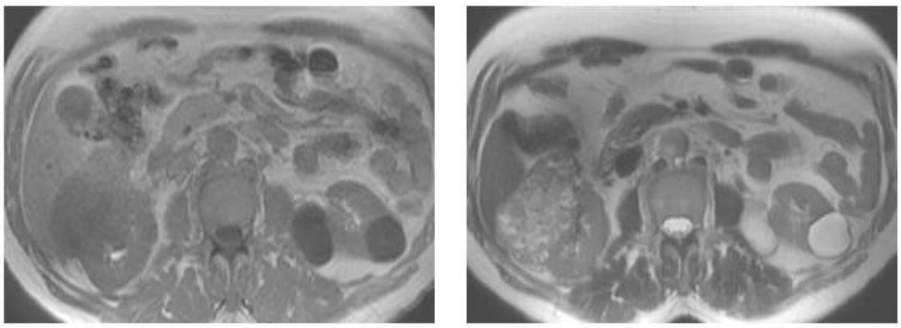

Fig (2) axial images of basic non enhanced MRI sequence including T1and T2 , mass show low signal on TI and high signal on T2

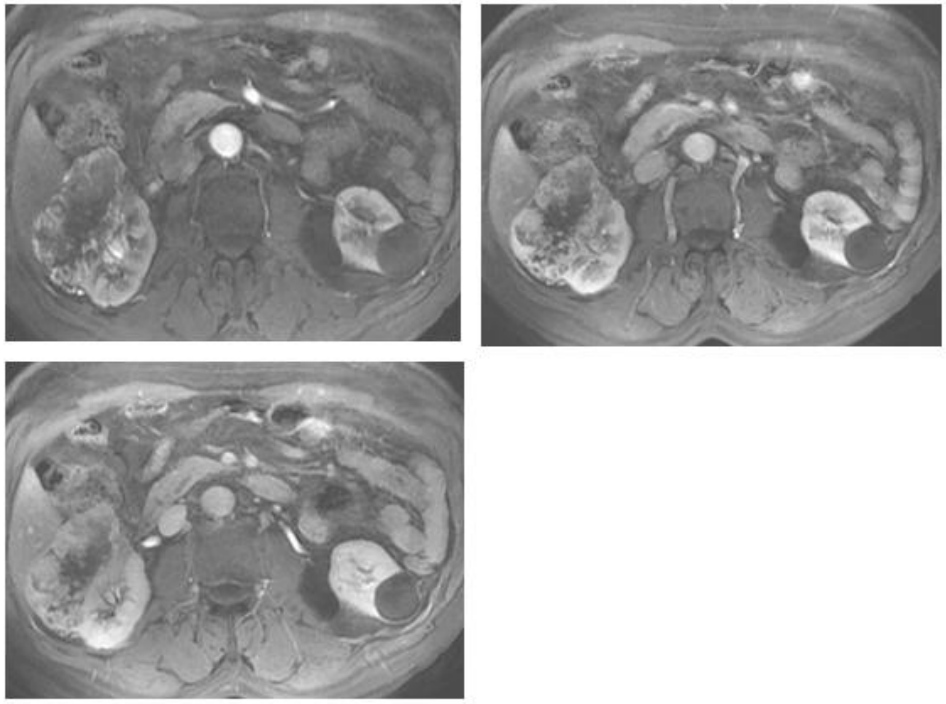

Fig (3): axial images of dynamic enhanced MRI showing rightlarge heterogeneous enhanced renal solid mass at early phases and wash out at delayed phase .

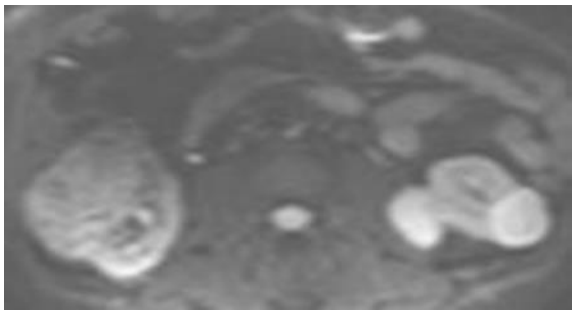

Fig (4): axial image of Diffusion WI MRI sequence ,renal mass showsrestricted diffusion.

Discussion

New TNM classification consider many numbers for staging 4 cm , 7 cm and 10 cm in diameter reflects the impact of tumor size on prognosis the more the lesion is small , the more to be confined to the kidney with in the renal capsule , the best prognosis is expected ***(7)*** **.**

In our study CT and MRI show the same accuracy in evaluate size of the lesions, regarding measuring maximum diameter.

In our study 7 renal masses are less than 4 cm represent about 23%, 10 masses between 4 cm to 7cm represent 33%, 8 masses between 7 cm to 10 cm represent 27%, 5 masses are more than 10 cm represent 17% of the patients

In our study RCC masses associated with tumor calcifications seen in 2 patients (7%).

Renal cell carcinoma is associated with calcification in a small percentage of patients ***(8).***

In our study 28 solid masses located in the danger zone between 20 – 70 HUs, two cystic masses have less attenuation values.

Attenuation values that cross into 20–70 HU ―danger zone‖ on unenhanced CT should raise suspicion for possible malignancy and further workup should be considered ***(8)*** **.**

It was reported [(8)] that none of the pathologically proven RCCs were noted to have attenuation values that fell completely outside of the 20–70 HU danger zone, implying that incidental lesions found on unenhanced CT with internal ROI attenuation values entirely outside this zone may confidently be called benign and the patient spared the cost and anxiety of further workup. Specifically, homogeneous lesions consistently measuring less than 20 HU should represent benign cysts (or angiomyolipomas if > 0 HU because of macroscopic fat) and homogeneous lesions measuring greater than 70 HU should represent high-attenuation benign cysts. Not surprisingly, a number of benign lesions also entered the danger zone, Although the 20–70 HU range is clearly not specific for RCC, it appears that ROI attenuation values entirely outside this range are specific for benignity.

It was stated [(9)] that the attenuation values of clear, papillary, and chromophobe renal carcinomas did not differ on unenhanced scans.

Our data add to this previous study by confirming that the 20–70 HU range is a very sensitive indicator for RCC detection.

In our study T2 hyperintense to moderate signal is seen in 28 renal masses (26 solid renal masses and two complex cystic masses). Two solid renal masses show T2 hypointense signal.

It was reported that small papillary RCC is typically T2 hypointense and clear cell RCC is typically T2 hyperintense [(10)]. When a T2 hypointense renal neoplasm in encountered in clinical practice, clear cell RCC is unlikely, and the differential diagnosis can be narrowed to include papillary RCC and other entities such as angiomyolipoma with minimal fat and

the rare solitary fibrous tumor of the kidney. When a small T2 hyperintense renal neoplasm is encountered, clear cell RCC is strongly favored. Contrary to prior reports, the T2 hypointense feature of papillary RCCs correlated only with predominantly papillary architecture, not with the presence of hemosiderin or other iron-containing materials.

Papillary RCCs and clear cell RCCs had a similar appearance and signal intensity ratio on T1-weighted images [(10)].

In our study 26 solid renal masses show T2 hyperintense feature, 25 renal masses of them proven to be clear type , only one of them proven to be papillary type RCC ,may be due to its large size .

In our study 2 solid renal masses show T2 hypointense feature of papillary RCCs and proved to be papillary RCCs subtype.

In our study 28 renal solid masses and two complex cystic lesions 25 solid renal masses show prominent enhancement. Three renal solid masses show minimally or no significant enhancement. One complex cystic mass shows enhanced thick septations and thick enhanced wall.

One complex cystic mass shows nodular solid enhanced component and thick enhanced wall.

A report on CT of 198 renal masses with pathologic correlation showed that clear cell carcinomas, along with oncocytomas, enhance avidly was stated [(5)]; while chromophobe carcinomas and lipid poor angiomyolipomas enhance moderately; and papillary carcinomas demonstrate the least enhancement.

It was reported [(11)] that contrast enhancement was greatest in clear cell carcinomas, intermediate in chromophobe carcinomas, and lowest in papillary carcinomas .Usually possible to discriminate between these tumors on the basis of visual or qualitative inspection of contrast enhancement, yet quantitative methods of measuring enhancement may provide a higher degree of accuracy with less subjective variability**.**

Dynamic contrast material–enhanced computed tomography (CT) or magnetic resonance (MR) imaging provides a useful method of detection, characterization , diagnosis of RCC and even differentiating subtypes of RCC ***(12)*****.**

Degree of enhancement evaluated in early cortico-medullary and nephrographic phases .It is often possible to subjectively identify enhancement within a renal mass with a side-by-side comparison of the unenhanced and contrast-enhanced images, particularly in hypervascular masses ***(12)*****.**

In our study renal solid masses enhancement pattern subdivided into heterogeneous or homogenous enhancement. Heterogeneous enhancement of solid renal masses seen in about 23 cases of 25 represent about 92% .Homogenous enhancement of solid renal masses seen in two cases of 25 represent about 8 %.

It was stated that heterogeneous enhancement was significantly higher in conventional clear renal carcinoma (68%) than in chromophobe renal carcinoma (23%) , whereas the

frequency of homogeneous enhancement was higher in chromophobe renal carcinoma than in conventional renal carcinoma and papillary renal carcinomas [(9)].

In our study all heterogeneous enhanced RCC proved to be clear type RCC . In our study two homogenous prominent enhanced RCC also are proved to be clear type RCC.

In our study we have no any case of chromophobic RCC, inspite of suspect one solid lesion of being moderately enhanced and more homogenous pattern yet histopathology proved to be clear type.

It was stated that MDCT with 3D reformations and MRI have similar overall staging accuracies for RCC [(13)].

In our study in spite of use 16 and 64 MDCT , yet MRI has better contrast discrimination specially in evaluation of minimally enhanced renal masses yet both have similar overall staging accuracies for RCC [(13)].

Some researchers characterized renal lesions using DWI [(14)]. They concluded that DWI can be used to characterize renal lesions especially; it can be used to differentiate solid RCC from oncocytomas **.**

In our study 25 masses show evident restricted diffusion with ADC values less than or equal to 1.92×10–3 mm2/s. 3 cases show ADC values more than 1.92×10–3 mm2/s. two of them are complex cyst (T2 shine through artifact) and one solid masse inspite of proved histopathologically of being RCC mass .

Under and over staging of perinephric invasion are the most staging errors at CT and MRI . the most specific finding are the presence of enhancing nodules in perinephric space is highly specific but less sensitive**.** Perinephric stranding and thickening of Gerota's fascia. does not consider reliable signs and is found in about half of patients with localized tumors .perinephric stranding may be caused by edema , vascular engorgement , or previous inflammation .but fortunately this limitation does not affect the case management since RCC with perinephric fatty infiltration candidate for nephrectomy [(12)].

In our study 4 masses show perinephric invasion represent about 14% , three of them show enhanced nodules , one of them show thick reticulations in perinepheric fat .

MRI in our study shows more accurate evaluation of perinephric infiltration regarding nodules and reticulations

Venous extension is optimally shown during corticomedullary phase of enhancement .The specific sign of venous thrombus is the presence of filling defect with the enhanced vein . Ancillary signs including abrupt change of the vein caliber and collateral surrounding [(15)].

Imaging can differentiate bland from malignant thrombus by heterogeneous enhancement of tuomral thrombus due to neovascularities also direct continuation of the thrombus with the primary tumor also suggest tumoral thrombus [(12)].

Precise delineation of the superior extent of the thrombus is essential for the surgery plan ***(12)***.

It was stated that MRI is particularly useful for delineating the superior extent of tumor in the IVC than CT [(4)].

Current MDCT technique has similar reported sensitivity and specificity as MRI for detecting renal vein and IVC thrombus was reported [(13)].

In our study 7 cases show tumoral renal vein thrombosis represent about 23% . Two of them extending to IVC represent about 6 %, no any thrombosis extending above diaphragm.

In our study MRI have more better resolution and lineation of IVC and renal vein as well as more accurate estimation of enhanced tumoral thrombosis , yet MDCT 64 with coronal and sagittal reconstruction not miss any of the thrombosis in our study .

Imaging diagnosis of Lymph node metastasis is reliant on nodal enlargement of greater than 1 [cm] in short axis diameter [(15)].

In our study 5 masses show associated enlarged regional LNs represent about 17 %

CT and MRI with contrast show the same accuracy in detection and evaluation of enhancement pattern of the lymph nodes .

RCC metastasis most frequently to neighboring organs, the lungs, mediastinum, bones and liver . less commonly sites include contra lateral kidney, adrenal gland, and brain [(16)].

In our study 6 patients have distant deposits , 4 to the lung , one to the pleura and the lung and one to the lumbar spine .

CT is more practical to evaluate chest and to detecting pulmonary nodules .

MRI is more practical to evaluate bone deposits .

Cystic renal masses with complex features at imaging often undergo surgical resection because of the risk of malignancy. Because cystic renal cell carcinomas (RCCs), benign complicated cysts, and other cystic tumors can be indistinguishable at gross pathologic inspection, and a definitive diagnosis can require a histologic examination, an overlap in imaging findings is not unexpected. complex cystic renal masses including cystic clear cell carcinoma, multilocular cystic RCC, cystic nephroma, mixed epithelial and stromal tumor, localized cystic renal disease, and complex benign cystic renal lesion ***(17)***.

It was stated that CT and MRI findings are similar in most cystic renal masses. In some cases, MRI may depict additional septa, thickening of the wall or septa, or enhancement [(17).]

CT and MR imaging findings were similar in the majority of cystic renal masses [(18)]. In some cases, however, MR images may depict additional septa, thickening of the wall and/or septa, or enhancement, which may lead to an upgraded Bosniak cyst classification and can affect case management.

In our research we have many renal complex cystic masses , two of them proven by histopathology of being multilocular cystic

RCC, so we involving them in our study , representing about 7% of our patients .

In our study, MRI show marked accuracy and better resolution in detection and characterization of additional septa, thickening of the wall and/or septa, or enhancement . Yet in our study usage of MRI in evaluation of two complex renal cystic masses not lead to an upgraded Bosniak cyst classification.

Conclusion

The advent of MDCT and MRI machines and techniques led to better detection, earlier diagnosis, and proper evaluation of RCC

References

1. **Jemal A, Siegel R, Xu J, and Ward E(2010):** Cancer statistics, 2010. CA cancer J Clin ; 60:277–300.

2. ***Katherine K,Angela G ,Katherine Z ,Annick V, and Ivan P (2011):*** *Imaging in Renal Cell Carcinoma. Hematology/Oncology Clinics of North America journal;25(4): 687-715.*

3. ***Hsieh JJ, Purdue MP, Signoretti S, Swanton C, Albiges L, Schmidinger M, et al.*** *Renal cell carcinoma. Nat Rev Dis Primers. 2017 Mar 9;3:17009.*

4. ***Ng CS, Wood CG, Silverman PM, Tannir NM, Tamboli P,and Sandler CM(2008):*** *Renal cell carcinoma: diagnosis, staging, and surveillance. American Journal of Roentgenology;191:1220–1232.*

5. ***Zhang J, Lefkowitz RA, Ishill NM,Wang L, Moskowitz CS, Russo P, et al (2007):*** *Solid renal cortical tumors: differentiation with CT. Radiology journal;244:494–504.*

6. ***Wang H, Cheng L, Zhang X, Wang D, Guo A, , Gao Y , et al.(2010):*** *Renal Cell Carcinoma: Diffusion-weighted MR Imaging for Subtype Differentiation at 3.0 T. Radiology journal; 257, 135-143.*

7. ***Edge S. (2010):****American Joint Committee on Cancer. AJCC cancer staging manual, 7th ed. New York, NY: Springer .*

8. ***Pooler B, Pickhardt P, D. O'Connor S, Bruce R. (2012):*** *Renal Cell Carcinoma: Attenuation Values on Unenhanced CT.American Journal of Roentgenology;198:1115-1120.*

9. ***Kim JK, Kim TK, Ahn HJ, Kim CS, Kim KR, and Cho KS. (2002):*** *Differentiation of subtypes of renal cell carcinoma on helical CT scans. American Journal of Roentgenology;178(6):1499-506.*

10. ***Oliva M, Glickman J, Zou K, Teo S, Mortelé K,*** **Silverman S, et al**. ***(2009):*** *Renal Cell Carcinoma: T1 and T2 Signal Intensity Characteristics of Papillary and Clear Cell Types Correlated with Pathology .American Journal of Roentgenology.;192:1524-1530.*

11. ***Vargas H,Chaim J, Lefkowitz D, Lakhman Y, Zheng J, and Moskowitz C (2012):*** *Renal Cortical Tumors: Use of Multiphasic Contrast-enhanced MR Imaging to Differentiate Benign and Malignant Histologic Subtype September .Radiology J ;264: 200-230.*

12. ***Chaan S, Wood C, Silverman P, Tannir N, Tamboli P, and Sandler C(2008):****Renal Cell Carcinoma: Diagnosis, Staging, and Surveillance. American Journal of Roentgenology;191:1220-1232.*

13. ***Hallscheidt PJ, Fink C, and Haferkamp A (2005):****Preoperative staging of renal cell carcinoma with inferior vena cava thrombus using multidetector CT and MRI: prospective study with histopathological correlation. J Comput Assist Tomogr; 29:64–68.*

14. ***Taouli B, Thakur R, Mannelli L, Babb J, Kim S, Hecht E,*** **et al.** ***(2009):*** *Renal Lesions: Characterization with Diffusion-weighted Imaging versus Contrast-enhanced MR Imaging .Radiology journal ;251(2):398-407.*

15. ***Shinagare A, Krajewski K, Jagannathan J, and Ramaiya N(2012):*** *Genitourinary Imaging: Part 2, Role of Imaging in Medical Management of Advanced Renal Cell Carcinoma.American Journal of Roentgenology ;199:554-564.*

16. ***Chapin B, Delacroix S , and Wood C (2011):*** *Renal Cell Carcinoma: What the Surgeon and Treating Physician Need to Know. American Journal of Roentgenology ;196:1255-1262*

17. ***Freire M, and Remer E(2009) :****Clinical and Radiologic Features of Cystic Renal Masses.American Journal of Roentgenology.;192: 1367-1372.*

18. ***Israel GM, Hindman N, and Bosniak MA(2004):*** *Evaluation of cystic renal masses: comparison of CT and MR imaging by using the Bosniak classificationsystem.* Radiology *journal;231:365-371*

To cite this article: Omima M. Nagdy, Medhat M. Refaat, Hany H. Lotfy, Ahmed S. Mohamed. The Role of Multidetector Computed Tomography (MDCT) and Magnetic Resonance Imaging (MRI) in Diagnosis of Renal Cell Carcinoma. BMFJ 2023;40(Radiology): 114-128.