ORIGINAL ARTICLES

Diagnostic Performance of Computed Tomography Scan in The Evaluation of Renal Cell Carcinoma with Histopathological Correlation

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Abstract:

Background: *Renal cell carcinoma is the commonest renal malignancy worldwide. CT scan is a useful imaging modality to diagnose renal cell carcinoma.* ***Objective:*** *The study aims to evaluate diagnostic performance of Computed Tomography scan in the diagnosis of Renal cell carcinoma.* ***Methods:*** *This cross sectional study was conducted in the department of Radiology and Imaging of Dhaka Medical College and Hospital from July 2018 to June 2020. A total of 48 patients were included in the study after taking informed written consent. Detailed history was taken and thorough clinical examination were performed along with CT scan imaging and histopathological examination.* ***Results:*** *The mean age was 64.43+10.72 years with range from 32 to 73 years. Male to female ratio was 1.53:1. Majority of the patients had hematuria (54.16%), malaise (56.25%) and anemia. Majority (58.3%) patient had lesions d"4cm and 20(41.7%) patients had lesion size more than 4cm. Majority of the patients had hypodense lesions (54.1%) followed by isodense (41.6%) and hyperdense lesions (2.08%). Regarding CT diagnosis, 89.6% patient had RCC, 4.16% patients had TCC, 2.1% patient had lymphoma, 2.1% patient had oncocytoma and 2.1% patient had suprarenal gland adenoma. Regarding histopathological diagnosis, 87.55 patients had RCC, 4.16% patients had oncocytoma, 2.1% patient had lymphoma, 2.1% patient had TCC and 2.1% patient had suprarenal gland adenoma. CT scan showed a sensitivity, specificity, accuracy, PPV and NPV of 97.6%, 66.7%, 93.7%, 95.3% and 80% respectively in the evaluation of RCC.* ***Conclusion:*** *This study concludes that CT scan is a useful diagnostic modality in evaluation of renal cell carcinoma.*

Key words: *Renal Cell Carcinoma, CT scan.*

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Introduction:

Renal Cell Carcinoma is the commonest renal malignancy which accounts for approximately 3% of adult malignancies and 90-95% of neoplasms arising from the kidneys[1]. The prevalence of Renal Cell Carcinoma is increasing day by day and it is the 13th most common malignancy worldwide. Age is considered to be a risk factor, as the incidences of RCC in Europe and USA increase consistently with age and plateau near 70-75 years of age. The estimated risk of RCC for men between the ages of 50 and 59 is around 0.3% compared to 1.3% for individuals 70 years and older[2]. Other risk factors include cigarette smoking, obesity, exposure to petroleum products, chlorinated solvents, cadmium, lead, asbestos and ionizing radiation, Von Hippel Lindau disease, hereditary papillary renal cancer and long term dialysis, high protein diet and HIV infection[3]. The male to female ratio is 2.5:1[4]. Numerous familial/hereditary renal cancer syndromes are more likely to develop multifocal disease compared to non-syndromic RCC[2].

The site of origin is proximal convoluted tubule within the renal cortex. The classical triad of gross

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haematuria, flank pain, loin mass is seen in 7 to 10% of cases[5]. Owing to its retroperitoneal location, RCC remains asymptomatic and non-palpable until advanced disease develops[6]. Advanced Renal Cell Carcinomas are presented with other symptoms e.g. loin mass, malaise, bone pain, haemoptysis. These symptoms are usually related to metastasis and/or tumour bulk. RCC may also have atypical presentation such as upper Gastrointestinal symptoms without any specific G.I. involvement[7].

Many imaging modalities are available for the radiographic evaluation of renal tumors. These are Plain X-Ray, Intravenous Urography (IVU), Ultrasound, CT and MRI. An Ultrasound is preferred as an initial test as it is less time consuming, nonhazardous, cheaper and can be done with minimal preparation and in patients with renal impairment. IVU is now-a-days replaced by contrast enhanced CT scan of KUB region. CT is the primary investigation of choice for the detection, diagnosis and staging of Renal Cell Carcinoma. For planning of surgical approach & strategy, pre-operative CT scan has a vital role[8] as it can identify small lesions, extent of lesion and recurrence accurately. Lesions that are 3 cm or less are usually homogeneous. Larger lesions have variable appearances[9]. Once a small renal mass is characterized as enhancing (solid instead of cystic), the presumptive diagnosis becomes RCC[10]. The sensitivity of contrast enhanced CT scan is 98.3% in detection of various subtypes of RCC[11] and it is 75% sensitive and 100% specific in the detection of IVC involvement[12]. The overall accuracy of Multidetector CT in staging of preoperative RCC is 89%[20]. The attenuation of normal renal parenchyma on NECT typically ranges from 30 to 40 HU, a high density lesion of 40 to 70 HU often considered as a solid renal neoplasm and majority having a malignant diagnosis[13]. MRI has a primary role in tumor detection and staging, especially in patients in whom contrast enhanced CT scan is contraindicated. CT scan is superior to MRI in detection of calcification. Presence of necrosis and hemorrhage within the lesion can also be identified. It is relatively cheaper than MRI and less time consuming. MRI has another remarkable limitation in patients with claustrophobia[14]. Fine Needle Aspiration has a limited role in the evaluation of RCC, done only in those patients with clinically apparent metastatic disease, who are not surgical candidate and differentiating a primary RCC from a renal metastasis in patients with known primary of non-renal origin[5].

Since MRI is not available all over Bangladesh and since IVU and Ultrasound does not provide concluding information and there is paucity of literatures and very limited number of studies in regard of diagnostic performance of CT scan in our country thus this study is taken up to test the validity of CT scan in early diagnosis of RCC.

Methodology:

This study was carried out in the Department of Radiology and Imaging, DMCH, Dhaka from July 2018 to June 2020. All patients with clinical and or radiological USG diagnosis of Renal Cell Carcinoma referred to the Department of Radiology & Imaging, Dhaka Medical College & Hospital from Urology Department with a requisition of CT scan examination were included in the study irrespective of age and sex. Pregnant patients and those with history of local anesthetic allergy and/or anaphylaxis were excluded from the study. Purposive sampling technique was done for this observational cross-sectional type of study. Sample size was 48. Ethical clearance from institute and Informed written consent from patients were taken. Patients were then followed for collecting histopathology reports which was compared with CT diagnosis. Statistical analyses of the results were obtained by using window based computer software device with Statistical Packages for Social Sciences (SPSS-22.0).

CT imaging technique:

CT examination was performed using a multi detector 4th generation CT scanner, Hitachi Scenaria 128 slice whole body scanner with dual head automated injector. Both pre and post contrast scans were obtained with the patients in supine position using 2.5 mm collimation, 1.5 mm pitch, 120 KV, 150 mAS, 3-5 mm slice thickness with 5 mm interval. The included area was from the level of diaphragm to the pubic bone. Raw data was reconstructed with both soft tissue and bone algorithms & CT reformatted images in axial, coronal and sagittal planes were obtained. 50 ml of non-ionic water soluble iodinated contrast

medium (Iopamiro) 370 mg/ml strength is used for contrast examination. Immediately after completion of injection of contrast medium, 3-5mm contiguous slice was obtained. CT examination was interpreted on hard copy.

Diagnostic Criteria:[3]

On Non contrast scan:

Any Solid Lesion:

- Which disturbs the renal contour
- Having an irregular or lobulated margin
- With an attenuation value e 20 HU
- Attenuation similar to or less than renal parenchyma
- Having calcification: Central, Peripheral or both

After I/V Contrast:

- Most RCC enhance, but to a lesser degree than normal renal parenchyma
- Enhancement is often heterogeneous due to tumour necrosis or haemorrhage.

Secondary Features:

- Renal vein invasion
- Inferior vena cava invasion
- Perinephric invasion/ haemorrhage
- Lymph node enlargement
- Distant metastasis

Results & observations:

Table I

Showing distribution of the study patients by age (n=48)

Age (in year)	No of patients (n)	Percentage (%)
32-40	06	12.5
41- 50	08	16.7
51-60	12	25
61-70	18	37.5
> 70	04	8.3
Mean ± SD	64.43 ± 10.72 years	
Range (min-max)	32 – 73 yrs	

Table-I in above page shows age of the study patients and it was observed that majority of the patients (37.5%) was in the age group of 61-70 years followed by 12 (25%) in 51-60 years' group. The mean age was 64.43 ± 10.72 years with range from 32 to 73 years.

Among the 48 cases Male was 29 (60.4%) and female was 19 (39.6%) with a male female ratio of 1.53:1.

Table II

Showing distribution of the patients by clinical presentations (n=48)

Presentations	Frequency (n)*	Percentage (%)*
Hematuria	26	54.16
Flank Pain	12	25
Abdominal Mass	17	35.4
Weight Loss	9	18.75
Malaise	27	56.25
Anorexia	21	43.75
Hypertension	13	27.1
Anemia	18	37.5
Fever	8	16.7

* Multiple responses were observed in case of clinical presentations.

Table-II shows that more than half of the patients had hematuria (54.16%) and malaise (56.25%). Less common presentations were Anorexia 21 (43.75%), anemia 18(37.5%) abdominal mass 17(35.4%), hypertension 13(27.1%) and others.

In the study it was also seen that right kidney was involved in 27(56.25%) cases and left in 21(43.75%).

Table III

Showing distribution of the patients by size of renal mass (n=48)

Size (cm)	Number of patients (n)	Percentage (%)
2.5 – 3.5	08	16.7
3.6 – 4.5	09	18.8
4.6 – 5.5	15	31.2
5.6 – 6.5	05	10.4
6.6 – 7.5	07	14.6
7.6 – 8.5	04	8.3

Table-III shows distribution of the renal masses by size. It was observed that majority 15(31.2%) patients had lesions of 4.6–5.5 cm size, 09(18.8%)

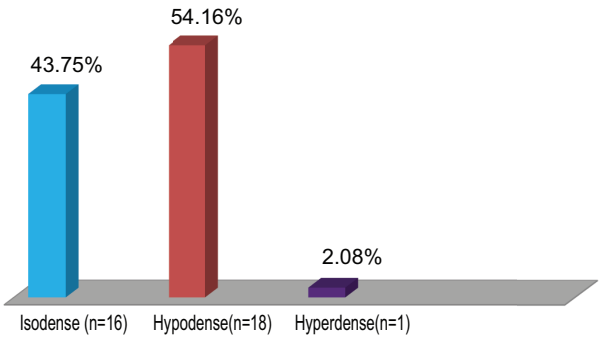

Fig.-1: *Bar diagram showing CT density of the renal masses (n= 48).*

patients had lesion size between 3.6–4.5 cm, 08(16.7%) between 2.5-3.5 cm, 07(14.6%) between 6.6-7.5 cm, 05(10.4%) between 5.6-6.5 cm and 04(8.3%)patients between 7.6-8.5 cm.

Study revealed that 16(43.75%) cases were isodense mass, 18(54.16%) were hypodense mass and in 01(2.08%) case the lesion was hyperdense on CT.

Study results also showed that in 40(83%) lesions there was no calcification, and calcification was present only in 08(17%) cases.

Lymph node involvement was seen in 15(31.25%) cases and absence of regional nodal involvement was observed in 33(68.75%) cases.

Adjacent fat invasion was seen in 15(31.25%) cases and in 33(68.75%) cases adjacent fat was free.

Table IV
Showing distribution of the study patients by CT diagnosis (n=48)

Lesion	Frequency (n)	Percentage (%)
Renal Cell Carcinoma	43	89.6
Transitional carcinoma	02	4.1
Lymphoma	1	2.1
Oncocytoma	1	2.1
Suprarenal gland adenoma	1	2.1
Total	48	100

Table-IV elaborates the CT diagnosis of lesions where 43 (89.6%) patients had RCC, 02(4.1%) patients had TCC and 01(2.1%) patient had lymphoma, 01(2.1%) patient had oncocytoma, 01(2.1%) patient had suprarenal gland adenoma.

Table V
Distribution of the study patients by histopathological diagnosis (n=48)

Lesion	Frequency (n)	Percentage (%)
Renal Cell Carcinoma	42	87.5
Transitional cell carcinoma	01	2.1
Lymphoma	01	2.1
Oncocytoma	02	4.1
Suprarenal gland adenoma	01	2.1
Metastasis	01	2.1
Total	48	100

Table-V shows histopathological diagnosis of lesions and it was observed that 42(87.5%) patients had RCC, 02(4.1%) patients had oncocytoma, 01(2.1%) patients had lymphoma, 01(2.1%) patient had transitional cell carcinoma and 01(2.1%) patient had supra renal gland adenoma respectively.

Table VI
Correlation of CT diagnosis of Renal Cell Carcinoma with histopathological diagnosis by Chi-square test (n=48)

CT/ diagnosis	Histopathological diagnosis		Total	*P value* <0.05
	Positive	Negative		
RCC positive	41(TP)	02(FP)	43	
RCC negative	01(FN)	04(TN)	05	
Total	42	06	48	

df= 1, p value <0.05, hence H_0 rejected, the result is significant.3 Abbreviations used are TP (True positive), FP (False positive), FN (False negative) and TN (True negative).

Table-VI shows the that CT diagnosis of Renal cell carcinoma has a significant statistical correlation

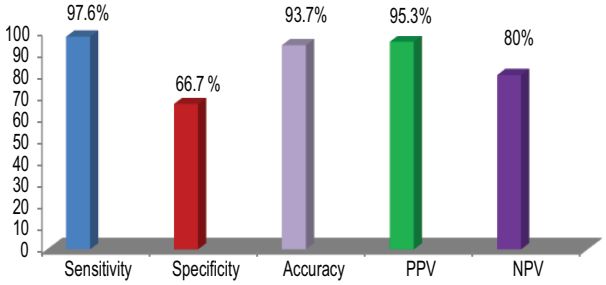

Figure 2: *Bar diagram showing validity test of MDCT for RCC*

with histopathological diagnosis with a p value of <0.05.

Figure shows the sensitivity of 97.6%, specificity of 66.7%, accuracy of 93.7%, positive predictive value of 95.3% and negative predictive value 80% of CT scan in the evaluation of renal cell carcinoma.

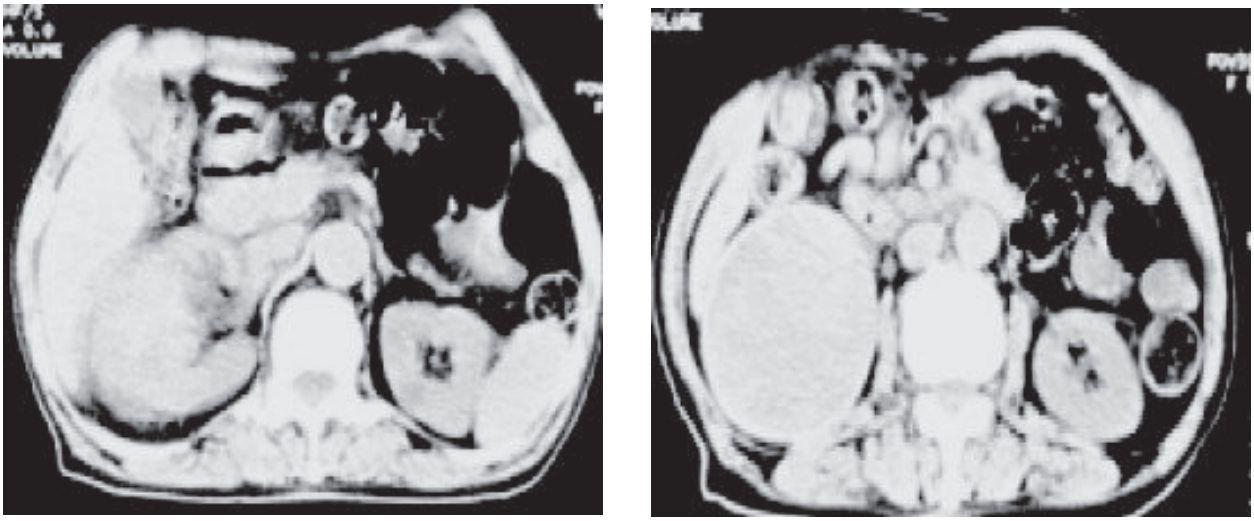

Fig 3a & 3b: *Showing multiple axial CECT scan of right sided RCC (Case 5)*

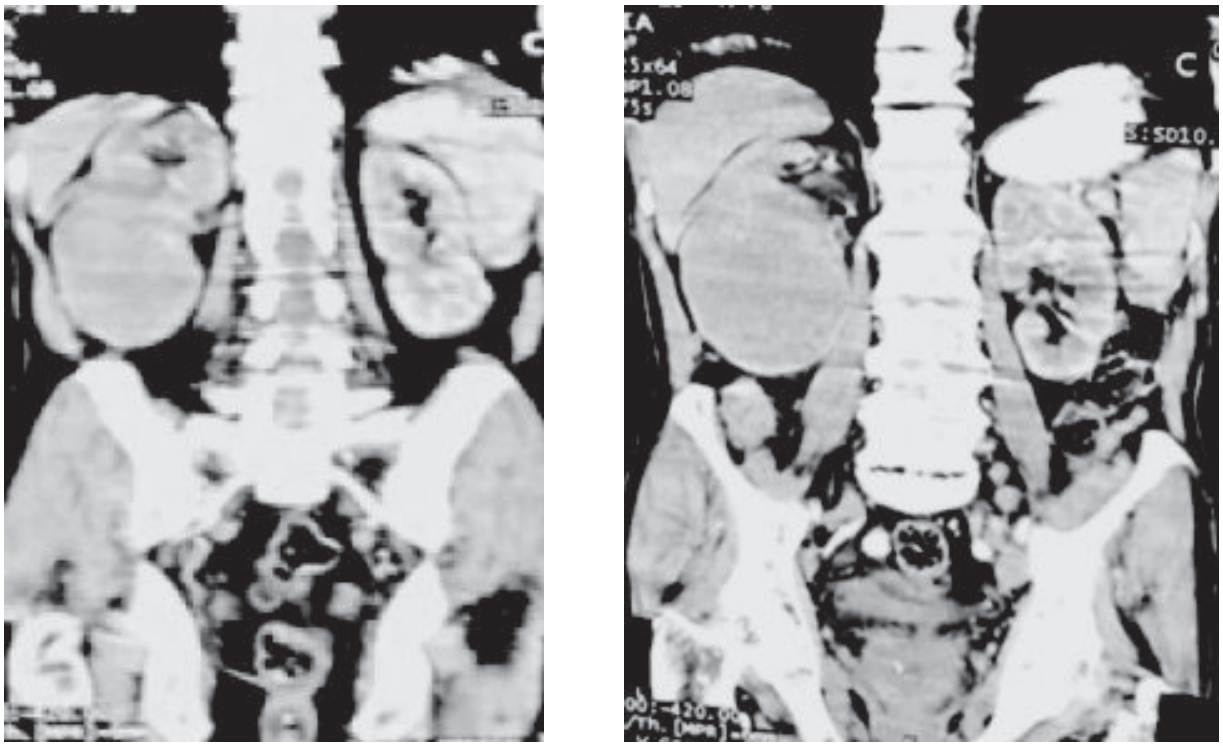

Fig 3c & 3d: *Showing multiple coronal contrast enhanced images of same patient at different levels (Case 5)*

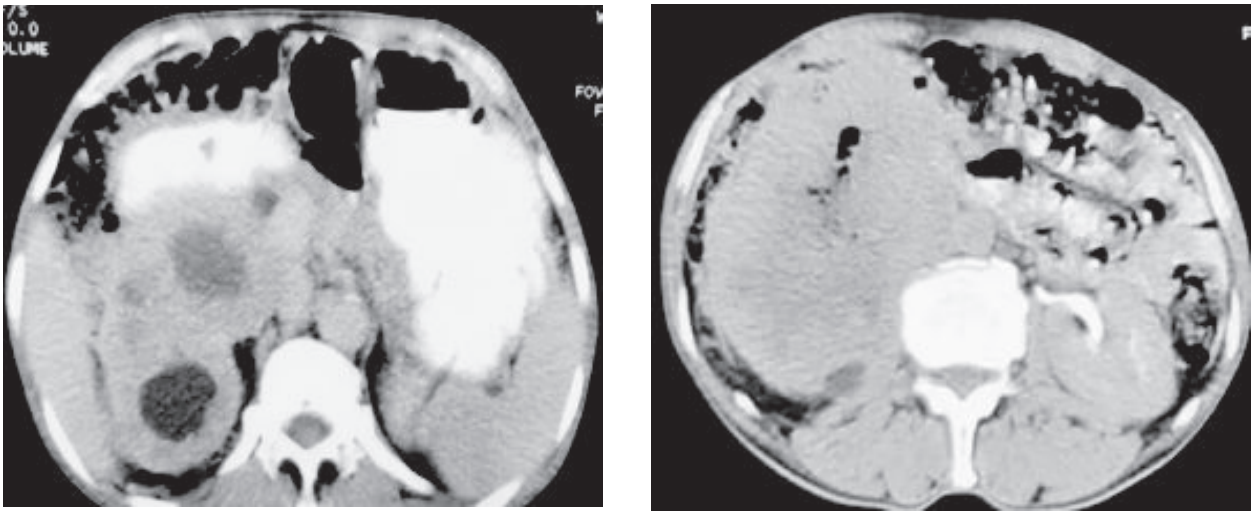

Fig 4a & 4b: *Multiple axial contrast enhanced CT Scan images of renal cell carcinoma in right kidney (Case 14)*

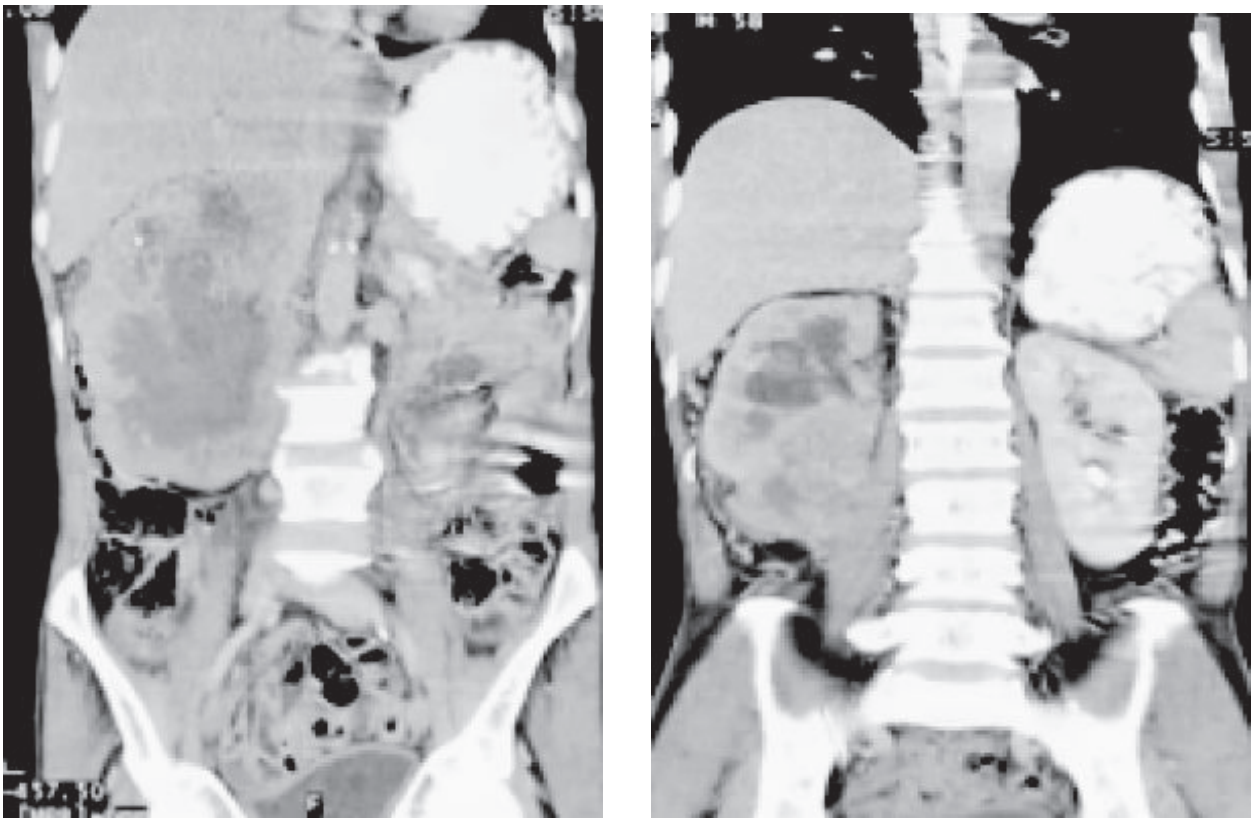

Fig 4c & 4d: *Multiple coronal contrast enhanced CT Scan of the same patient (Case 14) having renal cell carcinoma.*

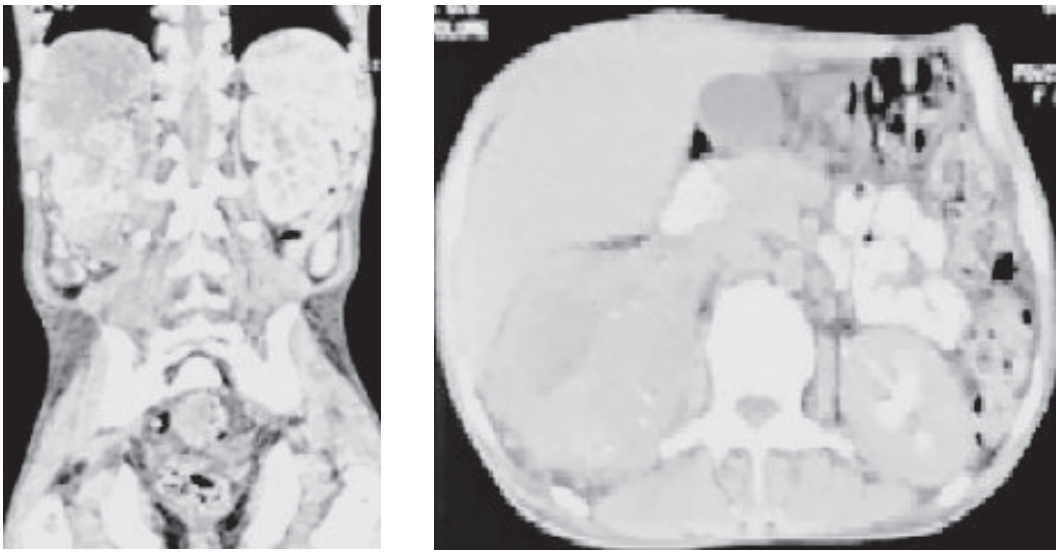

Fig 5a: *Showing multiple coronal and 5b: axial contrast enhanced CT scan of renal cell carcinoma (Case 22) in right kidney.*

Discussion:

This observational cross-sectional study was carried out with an aim to assess the diagnostic performances of Computed Tomography (CT) scan in the diagnosis of Renal Cell Carcinoma. A total of 48 patients with clinically and or radiologically suspected Renal Cell Carcinoma of all ages and sexes were included in this study.

Considering age of the patients, King et al.[15] observed that, RCC incidence rates increased with ages 70-74 years with a peak incidence of 52.8 years. Nazim et al.[16] found the mean age of population 57.6+/-12.7years. Turkvatan et al.[17] found mean age at presentation is 56 years. Amendola et al.[18] found the mean age of the RCC population 57 years with a range of 24 to 79 years. In the present study, it was observed that majority of the patients (37.5%) was in the age group of 61-70 years followed by 12 (25%) in the age group 51-60 years. The mean age was 64.43 ± 10.72 years which ranged from 32 to 73 years. Our study results slightly differ from the previous studies in that, mean age at presentation of our study population is a bit higher which signifies that diagnosis of RCC is somewhat delayed in our study compared to the previous studies.

In the current study, male was also predominantly affected where among 48 patients, 29 were male and 19 were female with a male to female ratio of 1.53:1. Nazim et al.[16] found 66% of their study population were male and 34% were female with a male to female ratio of 1.9:1. The ratio was 1.5:1 in the study of Turkvatan et al.[17] and 2:1 in the study of De Leon et al.[19] So, our results are almost identical to previous studies.

In our study, it is observed that, size of the lesion in majority of patients is 4.6 to 5.5 cm (31.2%) followed by 3.6 to 4.5 cm in 18.7% and 2.5 to 3.5 cm in 8% patients. Zhang et al.[20] found, mean+/-SD tumor size 4.9+/-2.3cm which is almost similar to our studies.

Considering side of involvement of the lesion, 56.25% occurred in right side and 43.75% tumors was in left side which goes with the observation of Zhang et al.[20] where majority (51%) tumours were right sided and 47.1% tumours were left sided. In another study conducted by Hassan et al.,[21] distribution of renal tumours were 91.3% in right kidney, 8% in left kidney and 1% in both kidneys. In all these studies, right kidney is more affected than left kidney.

Regarding the clinical characteristics of Renal Cell Carcinoma, it was observed in this present study that more than half of the patients had hematuria (54.16%) and malaise (56.25%). 25% patient reported flank pain, 35.4% patients presented with abdominal mass. Among those reporting systemic symptoms, weight loss (18.75%), malaise (56.25%) and anorexia (43.75%) were commonly reported. Vasudev et al.[22] found visible hematuria in 68%

cases, abdominal mass in 7% cases. Fatigue was reported in 62% cases, weight loss in 52% cases and loss of appetite in 38% cases. In both studies, haematuria was the most common presenting symptom compared to other symptoms.

Pooler et al.[23] found hypodense lesion in 24.9% patients, isodense in 63% patients and hyperdense in 2.1% patients in pre contrast CT examination. In our study majority of the patients (54.1%) had hypodense lesions followed by isodense (41.6%) and hyperdense lesions in 01 (2.08%) patients which is almost similar to previous study in that most tumors are hypodense followed by hyperdense lesions.

Regarding calcifications, it was observed in this study that 08(16.7%) patients had calcifications. Sheth et al.[24] found that approximately 30% RCC showed some calcification, which is a bit higher than our study.

In this current study, regarding CT diagnosis, it was observed that 43 (89.6%) patients had RCC, 02 (4.16%) patients had TCC and 01(2.1%) patient had lymphoma, 01(2.1%) patient had oncocytoma and 01(2.1%) patient had suprarenal gland adenoma.

Regarding histopathological diagnosis, in this current study it was observed that 42(87.5%) patients had RCC, 02 (4.16%) patients had oncocytoma, 01(2.1%) patients had 01 (2.1%) lymphoma, 01 (2.1%) patient had transitional cell carcinoma and 01 (2.1%) patient had suprarenal gland adenoma respectively.

Regarding the comparison between histopathological and CT diagnosis in evaluation of RCC it was observed in this current study that 41 (Forty-one) cases were true positive, 02 (Two) cases were false positive, 01(One) case was false negative and 04 (Four) cases were true negative. Taking histopathology as the gold standard the validity of CT in evaluation of RCC sensitivity, specificity, accuracy, PPV and NPV was 97.6%, 66.7%, 93.7%, 95.3% and 80% respectively. Catalano et al.[25] conducted similar study and found a sensitivity, specificity, accuracy, PPV and NPV of 96%, 93%, 95%, 100% and 93% respectively which is on a par with our study. Chi square test, correlation of CT diagnosis of Renal Cell Carcinoma with histopathological diagnosis showed, the p-value is significant (<0.05). With the results of present study, it can be concluded that CT is a sensitive and specific diagnostic modality for evaluation of RCC.

References:

1. McLaughlin JK, Lipworth L & Tarone RE. Epidemiologic aspects of Renal Cell Carcinoma. In *Seminars in oncology* 2006, October Vol. 33, No. 5, pp. 527-533. WB Saunders.
2. De Leon AD and Pedrosa I. Imaging and screening of kidney cancer. *Radiologic Clinics 2017*, *55*(6), pp.1235-1250.
3. Haaga JR, Lanzieri CF & Gilkeson RC. *CT and MR Imaging of the whole body* 2003, 4th edn, Vol 1. Pp. 1537-1563, Mosby, Missouri.
4. Sutton D. *A textbook of Radiology and Imaging*, 2003, 7th edn, vol 2, pp. 885-954, Churchill Livingstone & Imprint of Elsevier Ltd, London.
5. Tanagho EA & McAninch JW. *Smith's general urology* 2008, 7th edn, pp. 330-339, Lange, McGraw-Hill, USA.
6. Akpayak IC, Igho EO, Salaam AJ and Shuaibu SI. Multidetector computed tomography scan for renal cell carcinoma: A review. *Journal of Medicine in the Tropics*, 2017, *19*(2), pp.81-85.
7. Ojha U. and Ojha V. Renal Cell Carcinoma presenting as nonspecific gastrointestinal symptoms: a case report. *International Medical Case Reports Journal* 2018, 11, p.345.
8. Nazim SM, Ather MH, Hafeez K and Salam B. Accuracy of multidetector CT scans in staging of renal carcinoma. *International Journal of Surgery*, 2011, *9*(1), pp.86-90.
9. Coll DM and Smith RC. Update on radiological imaging of Renal Cell Carcinoma. *BJU international 2007*, 99(5b), pp.1217-1222.
10. Schieda N, Lim RS, McInnes MDF, Thomassin I, Renard-Penna R, Tavolaro S and Cornelis FH. Characterization of small (< 4 cm) solid renal masses by computed

tomography and magnetic resonance imaging: current evidence and further development. *Diagnostic and interventional imaging* 2018, 99(7-8), pp.443-455.

11. Bahadoram S, Davoodi M, Hassanzadeh S, Bahadoram M, Barahman M and Mafakher L. Renal cell carcinoma: an overview of the epidemiology, diagnosis, and treatment. *G Ital Nefrol 2022*, *39*(3), p.1.

12. Khan AR, Anwar K, Fatima N and Khan SF. Comparison of CT scan and colour flow Doppler ultrasound in detecting venous tumour thrombous in Renal Cell Carcinoma. *J Ayub Med Coll Abbottabad*, 2008, *20*(3), pp.47-50.

13. Hsu TH, Jeffrey Jr RB, Chon C and Presti Jr JC. Laparoscopic radical nephrectomy incorporating intraoperative ultrasonography for renal cell carcinoma with renal vein tumor thrombus. *Urology 2003*, *61*(6), pp.1246-1248.

14. Lenis AT, Burton CS, Golla V, Pooli A, Faiena I, Johnson DC, Salmasi A, Drakaki A, Gollapudi K, Blumberg J and Pantuck AJ. Cytoreductive nephrectomy in patients with metastatic renal cell carcinoma and venous thrombus—Trends and effect on overall survival. In *Urologic Oncology: Seminars and Original Investigations*,2019, September, Vol. 37, No. 9, pp. 577-e9). Elsevier.

15. King SC, Pollack LA, Li J, King JB and Master VA. Continued increase in incidence of renal cell carcinoma, especially in young patients and high grade disease: United States 2001 to 2010. *The Journal of urology*, 2014, *191*(6), pp.1665-1670.

16. Türkvatan A, Akdur PÖ, Altinel M, Ölçer T, Turhan N, Cumhur T, Akinci S and Özkul F. Preoperative staging of renal cell carcinoma with multidetector CT. *Diagnostic and Interventional Radiology*, 2009, *15*(1), p.22.

17. Amendola MA, Bree RL, Pollack HM, Francis IR, Glazer GM, Jafri SZ and Tomaszewski JE. Small Renal Cell Carcinomas: resolving a diagnostic dilemma. *Radiology*, 1988, *166*(3), pp.637-641.

18. De Leon AD and Pedrosa I. Imaging and screening of kidney cancer. *Radiologic Clinics 2017*, *55*(6), pp.1235-1250.

19. Zhang C, Li X, Hao H, Yu W, He Z and Zhou L. The correlation between size of renal cell carcinoma and its histopathological characteristics: a single center study of 1867 renal cell carcinoma cases. *BJU international*, 2012,*110*(11b), pp. E481-E485.

20. Vasudev NS, Wilson M, Stewart GD, Adeyoju A, Cartledge J, Kimuli M, Datta S, Hanbury D, Hrouda D, Oades G and Patel P. Challenges of early renal cancer detection: symptom patterns and incidental diagnosis rate in a multicentre prospective UK cohort of patients presenting with suspected renal cancer. *BMJ open*, 2020, *10*(5), p.e035938.

21. Pooler BD, Pickhardt PJ, O'Connor SD, Bruce RJ, Patel SR and Nakada SY. Renal cell carcinoma: attenuation values on unenhanced CT. *American Journal of Roentgenology*, 2012, *198*(5), pp.1115-1120.

22. Sheth S, Scatarige JC, Horton KM, Corl FM and Fishman EK. Current concepts in the diagnosis and management of renal cell carcinoma: role of multidetector CT and three-dimensional CT. *Radiographics*, 2001, *21*(suppl_1), pp. S237-S254.c

23. Catalano C, Fraioli F, Laghi A, Napoli A, Pediconi F, Danti M, Nardis P and Passariello R. High-resolution multidetector CT in the preoperative evaluation of patients with Renal Cell Carcinoma. *American Journal of Roentgenology 2003*, *180*(5), pp.1271-1277.