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CHARACTERISTICS OF SOLID RENAL MASSES ACCORDING TO COMPUTED TOMOGRAPHY RADIOLOGICAL FEATURES

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ABSTRACT

Background: CT has rapidly become a highly effective diagnostic tool for a wide range of urinary tract disorders, including renal masses. has a significant impact on the diagnosis, treatment, and follow-up. Computed tomography is a quick, simple, safe diagnostic imaging method that can provide important details regarding a variety of kidney diseases. **Objective:** To describe the characteristics renal solid masses based on CT-scan radiological features. **Patients and Methods:** A quasi-experimental study was conducted at the department of radiology in Al Ibn Sina teaching hospital (CT-scan unit) during the period from August 2024 to the end of September 2024. Sixty patients with a known instance of solid renal mass, usually via ultrasound or other imaging modalities (complex or simple cystic masses are excluded), were sent to the CT facility for assessment. The diagnosis and staging of the patients in this study were determined by surgical and pathological findings after doing partial or complete nephrectomy, or FNAC. **Results:** A total of 60 patients, ranging in age from 6 months to 81 years, participated in this prospective study, with a mean age of 57.6. 35 (58.3 %) were male and 23 (42.7%) were female and male to femfale ratio 1.6:1. The study shows that the age groups of 50 years and above are more prevalent than the ages of less than 50 years, right side is more prevalent than left side, fifty-two cases (86.7%) show malignant tumor while eight cases (13.3%) have benign tumor, renal cell carcinoma (RCC) was prevalent among (70%) patients. The mean and median size of RCC in the study are 4.6 and 5.5 cm respectively with range between 2-9 cm, located predominantly at the lower zone of the kidneys and commonly at stage 1 and 3 among the study population. (69%) of the patients having somewhere tumor extent. **Conclusion:** CT is a widely used diagnostic and characterization tool for patients with renal masses because it provides excellent anatomical information and is quick, accessible, non-invasive, and operator independent. However; certain limitations, primarily in the areas of perirenal invasion and lymph node involvement, but it exhibits an excellent precision in both close and far metastases, as well as venous extension.

KEYWORDS: CT-scan, solid, Renal, Mass, Mosul, Iraq.

1- INTRODUCTION

The normal patient has two kidneys, each with its own renal sinus fat, arteries, urothelial structures, and peripheral cortex and central medulla.[1] At the level of T10-L2, the kidneys are situated in the retroperitoneal region on either side of the vertebral bodies.[2] From the ages of 20 to 50, renal length is rather steady at 9 to 13 cm and thereafter gradually diminishes.[3] The cortical extensions that lie between the renal pyramids are referred to as the Bertin columns.[4] The renal outline has an anteromedial break at the hilus, where the vascular pedicle enters.[5] compared to the liver's attenuation, the densities of the renal cortex and medulla on non-enhanced CT are very similar, the normal renal parenchyma measures between 30 and 60 HU indicating an intermediate density. The central renal sinus has fat attenuation with linear fluid-attenuation renal vessels coursing from the aorta and toward the inferior vena cava.[6-7] As shown in figure 1.

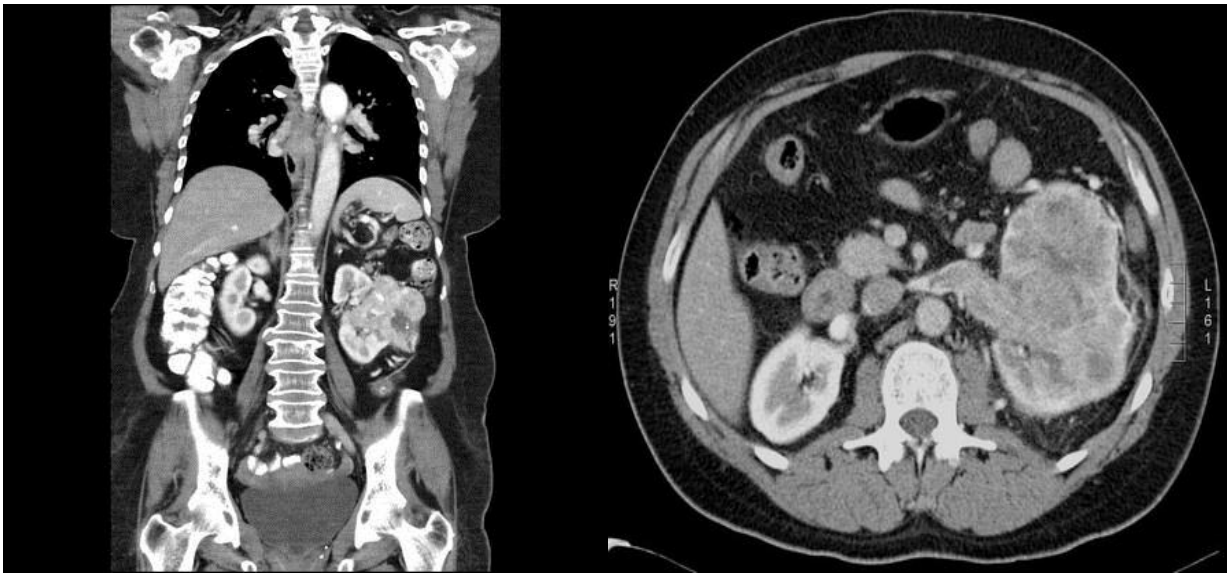

Figure 1: Renal Cell Carcinoma.

Depending on the capture time, four different stages of renal enhancement can be observed. These stages are timed differently depending on how quickly intravenous contrast is injected. Using a big antecubital vein, injection rate is frequently done by 100–120 ml of non-ionic contrast at a speed of 3 ml/s. The renal arteries opacify to their maximum during this brief phase, which starts 15–25 seconds after the intravenous contrast infusion is started.[8-10] During the late arterial phase, the renal veins typically opacify as well. Imaging prospective kidney donors who may have renal artery disease is crucial at this time.[11] The optimal time to show the kidney's structure is during the "cortico-medullary phase," which occurs around 30 seconds after iodinated contrast material is injected intravenously. While the optimal time to distinguish between a renal mass and the normal renal medulla is during the homogeneously dense nephrographic phase, which occurs approximately 80 seconds after the injection begins and lasts up to 180 seconds. In cases where the medulla and cortex have equal enhancement, the medulla may ultimately exhibit a greater degree of attenuation than the cortex.[12-15] The collecting system, which includes the calyces, infundibula, and renal pelvis visible in the excretory or urographic phase, usually starts three to five minutes after injection.[16] As contrast is being expelled from the renal tubules at this point, the renal medulla may be marginally more enhanced than the cortex. Dense contrast fills the ureters, collecting systems, and ultimately the bladder during the excretory phase.[17] Conventional intravenous urography (IVU) is gradually being replaced by CT urography because it can assess the complete genitourinary tract in a single session, it is increasingly being employed for indications such as hematuria of unknown etiology. However, due to its reduced spatial resolution, it is still limited in evaluating the urothelium in comparison to IVU.[18-19]

A reconstructed image of the ureters that is improved by contrast media is possible with CT urography. The majority of contemporary scanners are capable of creating high-quality images; however, this technology is dependent on processing power of the workstation and scanner.[20] During the late excretory phase, conventional cross-sectional images are obtained using the helical scanner. The pictures are rebuilt into a CT urogram that resembles the IVU in terms of gross appearance.[21]

CT has rapidly become a highly effective diagnostic tool for a wide range of urinary tract disorders, including renal masses. has a significant impact on the diagnosis, treatment, and follow-up.[22] Computed tomography is a quick, simple, safe diagnostic imaging method that can provide important details regarding a variety of kidney diseases. Renal cystic disease, renal trauma, renal infections, abnormalities in renal blood flow, and hydronephrosis with unclear etiology can all be effectively assessed in patients using CT.[23-24]

Renal tumors are generally defined as any enhancing solid mass in the kidney. But it's also important to remember that not all enhancing solid renal masses are indicative of renal neoplasms.[25]

Renal tumors are a common clinical issue that are frequently seen in patients who have no symptoms. A kidney tumor's histological characteristics determine whether it is benign or malignant.[26] Researchers have put out a number of classification systems for renal masses over the years, but none of them have gained widespread acceptance as being both simple and comprehensive.[27]

Aim of the study: To describe the characteristics of renal solid masses based on CT-scan radiological features.

2- PATIENTS AND METHODS

Patients: A total of 60 patients, ranging in age from 6 months to 81 years, participated in this prospective

study, with a mean age of 57.6. The study was conducted in the radiology department of Ibn Sina Teaching Center. It extended from August 2024 until the end of September 2025. Patients with a known instance of solid renal mass, usually via ultrasound or other imaging modalities (complex or simple cystic masses are excluded), were sent to the CT facility for assessment. The diagnosis and staging of the patients in this study were determined by surgical and pathological findings after doing partial or complete nephrectomy, or FNAC.

Methods: A quasi-experimental study collected by recording CT scans date which are obtained by Philips 64 slice spiral scanner. Patients were fasting for 6 hours, sit in lying supine position and axial section with slice thickness (8 mm) and in case of small lesions we were used 5 mm. In all patients CT scan was done before and after IV contrast (unenhanced phase is required for fat, calcification and hemorrhage detection), the intravenous injection was scanned after 50 seconds for parenchymal phase which is better for tumor assessment and delay after 10 minutes for collecting system analysis. Using 20 HU as cutoff point for evaluation of enhancement state. Oral contrast (30 cc of gastrografin in 1 liters of water administrated orally 2 hours prior to scanning) was used. The characteristics of the masses on images were recorded for each examination. The size (the size was defined as the maximum diameter measured and in case of irregular shaped tumor the largest measurement was recorded), density, degree of enhancement, extension, and lymph node and venous involvement, all evaluated in axial and multi planar reconstruction.

3. RESULTS

In this study of 60 cases with mean age 57.6 years. 35 (58.3 %) were male and 23 (42.7%) were female and male to female ratio 1.6:1. As shown in table 3.1.

Table 3.1: Distribution of study population according to gender.

Gender	No.	Percent
Male	37	61.6
Female	23	38.4
Total	**60**	**100**

Table 3.2 shows distribution of study population according to groups of age. It's evidence that the age groups of 50 years and above are more prevalent than the ages of less than 50 years which indicated that the renal tumors affected middle to elder people more frequently. As shown in table 3.2 and Figure 3.1.

Table 3.2: Distribution of study population according to groups of age.

Groups of age	Gender				Total No.	Total %
	Male		Female			
0-less than 10	2	3.35	2	3.35	4	6.7
10-less than 20	0	0	1	1.7	1	1.7
20-less than 30	1	1.7	0	0	1	1.7
30-less than 40	1	1.7	2	3.3	3	5
40-less than 50	3	3.3	2	1.7	5	8.3
50-less than 60	14	23.3	7	11.7	21	35
60-less than 70	10	16.7	7	11.6	17	28.3
70 and above	4	6.65	4	6.65	8	13.3
Total	**35**	**58.3**	**25**	**41.7**	**60**	**100**

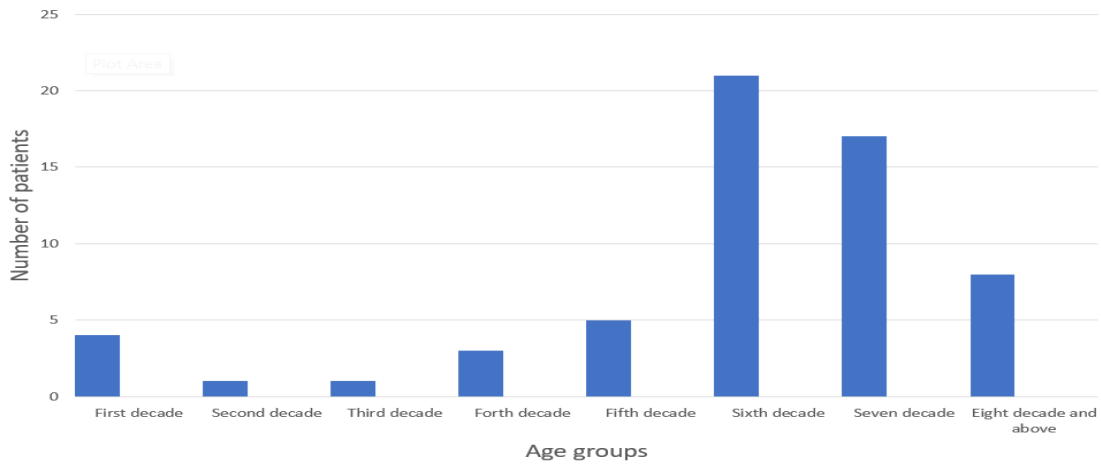

Figure 3.1: Histogram showing distribution of study population according to groups of age.

Table 3.3 and figure 3.2 show distribution of study population according to affected side, it's show that right side is more prevalent than left side with 33 (55%) and 27 (45%) respectively.

Table 3.3: Distribution of study population according to affected side.

Affected side	No.	Percent
Right	33	55
Left	27	45
Total	**60**	**100**

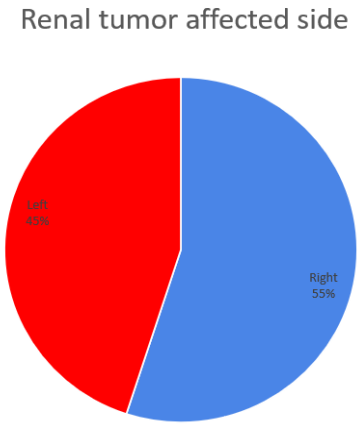

Figure 3.2: Pie chart showing distribution of study population according to affected side.

Table 3.4 and figure 3.3 illustrates different types of tumors among the study population. Fifty-two cases (86.7%) shown to have malignant tumor while eight cases (13.3%) have benign tumor. Regarding malignant tumors, it's evident that renal cell carcinoma (RCC) was prevalent among 42 (70%) patients followed by Wilms tumor among 5 (8.3%), followed by Transitional cell carcinoma (TCC) and lymphoma among 2 (3.35%) respectively and metastases among 1 (1.65%) of study population. From the other hand; regarding benign tumor, angiomyolipoma (AML) was prevalent among 6 (10%) and oncocytoma among 2 (3.35%) of study population.

Table 3.4: Distribution of study population according to types of tumors.

Types of the tumors		Male		Female		Total	
		No.	%	No.	%	No.	%
Malignant	RCC	27	45	15	25	42	70
	TCC	1	1.7	1	1.7	2	3.35
	Wilms	3	5	2	3.3	5	8.3
	Lymphoma	1	1.7	1	1.7	2	3.35
	Metastases	0	0	1	1.7	1	1.65
Benign	AML	2	3.3	4	6.7	6	10
	Oncocytoma	1	1.7	1	1.7	2	3.35
Total		**35**	**58.3**	**25**	**41.7**	**60**	**100**

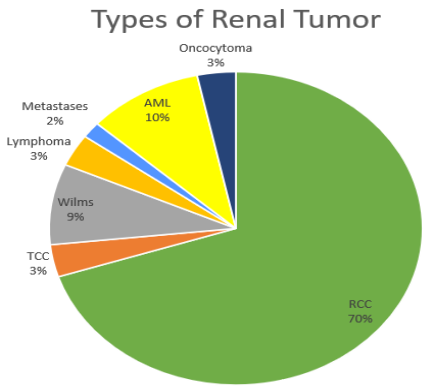

Figure 3.3: Pie chart showing distribution of study population according to types of tumors.

Regarding renal cell carcinoma, table 3.5 shows that right side was more prevalent than left side with 23 (57.5%) and 19 (42.5%) respectively. Furthermore; lower zone was prevalent among 17 (40.5%), while mid zone, upper zone and diffuse were prevalent among 13 (31%), 10 (23.8%) and 2 (4.7%) respectively. Additionally; the mean and median size in the study is shown to be 4.6 and 5.5 cm respectively with range between 2-9 cm.

Table 3.5: distribution of renal cell carcinoma according to affected side and site.

		No.	Percent
Affected side	Right	23	57.5
	Left	19	42.5
Affected site	Lower zone	17	40.5
	Upper zone	10	23.8
	Mid zone	13	31.0
	Diffuse	2	4.7
Tumor size	Mean size	4.6 cm	
	Median size	5.5 cm	

Table 3.6 expresses CT-scan findings of renal cell carcinoma pre contrast and post contrast. Regarding pre contrast state, homogeneous and heterogenous findings were prevalent among 21 (50%) of study population respectively. Moreover; isodense was found among 11 (26.1%) while hypodense was found among 9 (21.4%) and calcification was found among 10 (23.8%). From the other hand; post contrast shows heterogenous enhancement among 32 (76.2%) and homogenous enhancement among 10 (23.8%) of study population.

Table 3.6: Pre and Post contrast CT-scan findings of renal cell carcinoma.

Contrast state	Radiological findings	No.	Percent
Pre contrast	Homogeneous	21	50
	Heterogenous	21	50
	Isodense	11	26.1
	Hypodense	9	21.4
	Calcification	10	23.8
	Hemorrhage	2	4.7
Post contrast	Homogenous enhancement	10	23.8
	Heterogeneous enhancement	32	76.2

Table 3.7 shows distribution of renal cell carcinoma staging according to CT-scan findings, T1 founded among 18 (42.9%) of study population, followed by T3 among 16 (38.1%). T2 and T4 were founded among 4 (9.5%) respectively.

Table 3.7: Distribution of patients according to renal cell carcinoma staging.

Staging	Number	Percent
T1	18	42.9
T2	4	9.5
T3	16	38.1
T4	4	9.5
Total	**42**	**100**

Table 3.8 expresses renal cell carcinoma extent, out of 42 cases, 29 (69%) patients having somewhere tumor extent, renal vein invasion was prevalent among 12 (28.6%) followed by renal sinus invasion among 10 (23.8%), while perinephric fat invasion was prevalent among 6 (14.2%) and retrograde renal vein invasion among 1 (2.4%) of study population.

Table 3.8: Renal cell tumor extent.

Tumor extent	Number	Percent
Perinephric fat invasion	6	14.2
Renal sinus invasion	10	23.8
Renal vein invasion	12	28.6
Retrograde renal vein invasion (tumor nodule)	1	2.4
Total	29	69

4- DISCUSSION

The study explains that near to three fifths of the study population were males and two fifths were females and the mean age of study population was 57.6 years, and the renal tumor was more prevalent among the age groups of more than 50 years, these findings is parallel to Cassandre Garnier et al[28] and Sakib Mahmud et al findings.[29] Although the information about the tumor laterality and its anatomical location within the kidney may not be of that prognostic significance, right sided affection is more prevalent in this study which is runs with two studies conducted in middle east.[30,31] The majority of cases founded to be malignant (87%), while benign cases were only (13%), moreover, renal cell carcinoma found among 70% followed by angiomyolipoma among (10%) of the study population which is runs with Reem A. Al Zahrani et al and Sakib Mahmud et al findings.[29] Of notes; among those with renal cell cancer, right side founded to be more prevalent (57.5%). Moreover; the lower kidney zone was the most affected site (40.5%), the mean and median size in the study is shown to be 4.6 and 5.5 cm respectively with range between 2-9 cm and these results are near to results of studies made by Keruo Wang et al[32] and Sakib Mahmud et al.[29] Radiological features are important in determining the nature of the tumor and the aggressive behavior like necrosis, calcification, extension and enhancement. In this study considering 42 cases of RCC on unenhanced CT with mean attenuation 35 HU, 21 masses (50%) were homogeneous and 21 (50%) were heterogeneous, while to less extent 11 (26.1%) were isodense and 9 (21.4%) were hypodense. Aggressive behavior like calcification and hemorrhage were seen among 10 (23.8%) and 2 (4.7%) respectively. Post IV contrast all tumor showed enhancement with mean range 108 HU, majority showed heterogeneous enhancement 32 (76.2 %) and 10 (23.8 %) were enhanced homogeneously. This result is consistent with Cassandre Garnier et al.[28] The goals of radiologic imaging are to detect and stage the primary tumor and the CT is considered the main technique. Treatment of RCC is based on tumor stage which depend on tumor size, extent and venous involvement. Regarding staging 18 (43%) were T1, 4 (10%) T2, 16 (38%) T3, and 4 (10%) T4, comparable to what is reported by Reem A. Al Zahrani.[33] Tumor extent was shown in this study among 29 out of 42 patients with renal cell carcinoma, renal vein and sinus invasion was more prevalent than perinephric fat and retrograde renal vein invasion, which is consistent with the study of Reem A. Al Zahrani.[34]

5. CONCLUSION

1. CT is a widely used diagnostic and characterization tool for patients with renal masses because it provides excellent anatomical information and is quick, accessible, non-invasive, and operator independent.
2. For the staging and preoperative evaluation of solid renal tumors, CT is the tool that is most commonly used, however it has certain limitations, primarily in the areas of perirenal invasion and lymph node involvement. But it

exhibits an excellent precision in both close and far metastases, as well as venous extension.

3. Renal cell carcinoma is the commonest cause of solid renal mass.

4. The contrast medium should be injected dynamically instead of manual injection to increase the sensitivity of lesion detection.

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