Computed Tomography Performance in Renal Cystic Diseases

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ABSTRACT:

BACKGROUND:

Renal cysts represent notably dilated nephrons or collecting ducts. A cystic kidney is a kidney with three or more cysts. The accuracy of CT diagnosis of typical simple renal cyst approaches 100% but many renal cysts do not fulfill the criteria for simple renal cyst, such lesions vary from simple renal cysts which do not require surgery to renal neoplasms with cystic component that need surgical resection. Contrast-enhanced helical CT scanning has 96% sensitivity and 95% specificity in detecting carcinoma in acquired renal cystic diseases.

AIM OF STUDY:

To confirm the sensitivity, specificity and performance of the spiral computed tomography (CT) in diagnosis and evaluation of the renal cysts and to study the CT criteria which categorize and separate the renal cystic lesions that require surgery (malignant neoplasm) from those that do not.

METHODS:

Fifty patients were scanned with spiral CT, 22 of them were males and 28 were females, their ages ranging from 20-70 years with mean age 50 yeas old, these patients undergo CT examinations with and without contrast enhancing material. All the patients were proved to have renal cysts radiologically and symptomatically.

RESULTS:

The patients presented with cortical simple renal cysts were 16 patients (32% of all the cases). Medullary simple renal cyst were found in 9 patients (18% of the total number of cases). 3 patients presented with autosomal recessive and dominant poly cystic kidney disease (8% of total cases). 1 case found with cystic kidney associated with tuberous sclerosis (2% of total cases). Para-pelvic renal cysts are seen in 7 patients (14% of total cases). Cystic angiomyolipoma (fat density) are seen in 3 patients (6% of total cases). Acquired renal cystic disease is found in 1 patient (2% of total cases). Complicated renal cysts (hemorrhagic) are seen in 2 patients (4% of total cases). Medullary cystic diseases were found in 2 patients (4% of total cases). Multicystic dysplastic kidney was found in 1 patient (2% of total cases). Malignant Cystic kidney lesion (cystic renal cell carcinoma) was found in 1 patient (2% of total cases). Females are more affected than the male, 28 females (56%) while the affected males were 22 (44%). The more involved age group was between 50-59 years old, they were 15 patients (9males and 6 females). The left kidney (34%) is more involved than the right kidney (32%), while both kidneys were involved in (34%) of the cases.

CONCLUSION:

The spiral CT scan is the most sensitive imaging modality useful in diagnosis of cystic kidney and it is of valuable importance in evaluation and categorization of cystic renal masses in attempt to separate the lesions that require surgical resection from those do not.

KEYWORDS: Renal cystic disease, computed tomography (CT) performance.

INTRODUCTION:

Renal cyst usually represent notably dilated nephrons or collecting duct [1].simple renal cysts are the most common renal masses. Most are clinically insignificant, being discovered incidentally at autopsy or on imaging studies. Their frequency increase with age. Although the cause of renal cysts is unknown, their frequent occurrence in older patients suggests that they are acquired lesions.

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One third of people older than 50 years develop renal cysts [2]. Although most are simple cysts, renal cystic disease has multiple etiologies. Broad categories of cystic disease include the following:

1. Developmental: Multicystic dysplastic kidney (MCDK).
2. Genetic: Autosomal recessive polycystic kidney disease (ARPKD), autosomal dominant polycystic kidney disease (ADPKD), juvenile nephronophthisis (JNPHP), medullary cystic kidney disease (MCKD), glomerulocystic kidney disease (GCKD).

3. Cysts associated with systemic disease:
Von Hippel-Lindau syndrome (VHLS), tuberous sclerosis (TS) .
4. Acquired: Simple cysts, acquired cystic renal disease, medullary sponge kidney (MSK) .
5. Malignancy : Cystic renal cell carcinoma (RCC).
Cysts develop from renal tubule segments and most detach from the parent tubule after they grow to a few millimeters in size. Cyst development is generally attributed to increased proliferation of tubular epithelium, abnormalities in tubular cilia, and excessive fluid secretion. Typically, acquired cystic renal disease is asymptomatic but it is known to subsequently increase the risk of RCC [3].
Developmental cystic renal disease: MCDK is thought to arise from abnormal development of the metanephros. This may be a genetic effect or may reflect a defect in the ampullary bud (inducer tissue) or the blastema (responder tissue), with resultant poor nephron induction [4]. JNPHP affects 1 per 5000 persons. ADPKD has a bimodal distribution of onset, with some cases presenting in infancy or childhood [5]. In acquired cystic renal disease, cysts are present in 8-13% of patients with chronic renal failure prior to dialysis. Following initiation of therapy, 10-20% of patients have acquired cystic renal disease after 3 years of dialysis, 40-60% after 5 years, and more than 90% after 10 years [6].
Imaging of renal cysts: The accuracy of CT diagnosis of simple renal cyst approaches 100% if a renal mass strictly fulfills the following criteria:
1. Sharp margination and demarcation from surrounding renal parenchyma.
2. Smooth, thin wall
3. Homogeneous water density content with attenuation value of 0-20 Hounsfield unit (HU)
4. No enhancement after intravenous administration of contrast medium. If a renal cystic mass fulfills these CT criteria, no further evaluation is necessary [6,7]. Simple cyst: The most clinically significant aspect of a simple cyst is differentiating it from carcinoma. Simple-cyst walls occasionally calcify and, thus, radiographically mimic malignancy. If the ultrasonography findings are suspicious or equivocal, a CT scan is warranted.
CT scan criteria for a benign cyst include (1) sharp demarcation cyst with a smooth thin wall, (2) homogenous fluid within the cyst (typically with density <20 HU, although higher measurements may be found with a benign proteinaceous cyst or if hemorrhage is present in a benign cyst), and (3) no contrast enhancement. Enlargement of the cyst can raise the concern of malignancy, although the natural history of benign renal cysts does show progressive slow enlargement. Although CT is accurate in diagnosing simple renal cyst, interpretation of CT findings has some potential pitfalls . Small renal cysts may be volume-averaged with normal renal tissue, causing high attenuation values[6], or falsely high attenuation values may be caused by streak artifacts[7]. Acquired renal cystic disease (ARCD) : Diagnosis can be made if involvement is bilateral, with at least 4 cysts per kidney. Once cysts are observed sonographically, further evaluation with contrast-enhanced CT scan is indicated to rule out carcinoma. Contrast-enhanced helical CT scanning has 96% sensitivity and 95% specificity in detecting carcinoma. In patients who cannot tolerate ionic contrast, MRI may be useful to evaluate for neoplasms[8]. Inherited cystic renal disease (Autosomal dominant polycystic kidney disease): Typically, cysts first are observed radiographically in the second to third decades of life. With progression, the kidneys become enlarged with multiple spherical fluid-filled cysts (1-3 cm) that are appreciated readily with CT scanning, ultrasonography, or MRI. Sonographic criteria for ADPKD depend on patient age. Patients younger than 30 years probably have at least 2 cysts in 1 of the kidneys, patients aged 30-60 years probably have at least 2 cysts in each kidney, and patients older than 60 years generally have at least 4 cysts per kidney. Debris may produce heterogeneous cyst attenuation, and cysts may have fluid-fluid levels from hemorrhage. Hemorrhagic cysts demonstrate un-enhanced CT attenuation values of 40-100 Hounsfield units (HU).
Calcification may be observed in the cyst walls or in the parenchyma between cysts, and nephrocalcinosis or nephrolithiasis is observed in as many as 50% of patients. Calcification likelihood increases with age and is fairly common in patients older than 50 years. Contrast enhancement of the renal parenchyma provides an indication of the amount of functioning renal parenchyma that remains. The likelihood of hepatic cysts increases with age; 40% of patients demonstrate liver cysts by the fourth decade of life, and nearly 90% of patients have them by the sixth decade of life. When ADPKD presents in childhood, ultrasonography may reveal hyperechoic enlarged cystic kidneys, a pattern that may be difficult to differentiate from ARPKD. In this situation, family history and possible ultrasonography of the parents' or grandparents' kidneys is recommended. When malignancy or infected cysts are a concern, a contrast-enhanced CT scan can be performed.Patients should be screened for intracranial aneurysms. This can be readily accomplished non-invasively with magnetic resonance angiography (MRA).

Autosomal recessive polycystic kidney disease: Severe cases of this disease can be are detected with sonography in utero, with most cases detected in the third trimester of gestation. Pre-contrast CT scan images show enlarged smooth kidneys with low attenuation (likely representing the large volume of fluid in the collecting tubules).

Renal calcifications are frequently noted.

With contrast, poor opacification of the kidneys may be observed (with severe renal failure), and the physician may appreciate radial streaks of contrast extending from the cortical surface to the inner medulla. The classic radial streak pattern is best appreciated with IVP.

Liver disease: Ultrasonography demonstrates hepatomegaly with echogenic parenchyma (secondary to fibrosis), hepatic cysts, and dilatation of the peripheral hepatic ducts with fibrous bridging. Magnetic resonance cholangiography is more sensitive in detecting dilated biliary ducts [9,10].

Medullary sponge kidney (MSK): CT scan may show calcifications at the corticomedullary junction.

Glomerulocystic kidney disease: On CT, GCKD appears as numerous small cortical cysts. These do not enhance with contrast medium during CT scan.

JNPHP and MCKD: CT scan reveal bilaterally shrunken kidneys. On sonography, cysts are observed at the corticomedullary junction in a background of diffusely echogenic renal parenchyma [11].

Bosniak classification: Bosniak has described a classification scheme for renal cysts based on CT scan findings [12]:

1. Category I (simple cyst) - Thin wall without septa, calcifications, or solid components; measures water density (<20 HU) and does not enhance (<2% chance of malignancy) .
2. Category II (minimally complex cyst) - Thin wall (<1 mm) and no enhancement; may contain 1 or 2 hairline-thin septa, fine calcification, or short segment of slightly thickened calcification; includes high-attenuation lesions that are smaller than 3 cm (Malignancy rates in series range from 0-14%.
   Series with higher malignancy rates include IIF lesions.)
3. Category IIF (indeterminate) - Minimal enhancement and/or thickening of a hairline-thin smooth septum or wall; mildly thickened or nodular calcification; no enhancing soft -tissue components; includes non-enhancing high-attenuation lesions that are 3 cm or larger (approximately 20% likelihood of malignancy) .
4. Category III (suspicious indeterminate) –
   Multilocular lesion with multiple enhancing septae, uniform wall thickening, nodularity, or thick or irregular calcification (30-60% likelihood of malignancy)
5. Category IV (malignant) - Contains enhancing (>10 HU) large nodules or clearly solid components (>90% likelihood of malignancy)

PATIENT AND METHODS:

All the patients who included in this study were proved to have various renal cystic disorders by other imaging modalities such as ultrasound.

The total number of cases were 50 patients (22 males and 28 females), their ages range from 20-70 years and the mean of their age was 50 years.

The radiological investigation with CT were reviewed and data collected regarding patients characteristics, symptoms, cystic features and associated renal pathology.

CT examination was done natively and the contrast medium was injected in 30 cases to identify the vascular pattern of the renal cystic mass. Patient is placed supine on the CT table in comfortable situation and no patient preparation was required during the examination but mild sedative agents may be indicated in certain cases. Standard abdominal CT examination is performed in axial plane with caudal angulation to reduce the effect of the radiation with 8 mm. slice thickness and 0.8-1 mm. gap in between. CT scanning protocol for renal cell carcinoma (RCC) consist of a combination of non-enhanced and contrast enhanced CT in the corticomedullary and nephrographic phases with all precaution to avoid allergic reaction to the contrast agents especially in patient with previous history of allergic reaction.

The corticomedullary phase (25-27 sec. from the start of injection of contrast material) is best for evaluating venous extension of renal cell carcinoma (RCC). The nephrographic phase (80-180 sec. after the injection of the contrast material) is best for evaluating the renal mass.

Single detector and multidetector spiral CT allows rapid image acquisition through the entire kidney in a single breath hold during various phases of contrast enhancement after administration of single bolus of intravenous contrast material [13].

RESULTS:

Table1: Distribution of patients according to the age and gender

Number / Age	Total		Male		Female	
	No.	Percentage	No.	Percentage	No.	Percentage
20-29	6	12%	2	33%	4	67%
30-39	8	16%	1	13%	7	87%
40-49	10	20%	4	40%	6	60%
50-59	15	30%	9	60%	6	40%
60-70	11	22%	6	55%	5	45%
Total	50	100%	22	44%	28	56%

Table 2: The renal cystic size in correlation to the patient's ages

Size / Age	Total	< 1cm.	1-3cm.	3-6cm.	6-9cm	>9cm	confluent
20-29 y.	6	0	2	2	1	0	1
30-39 y.	8	0	2	3	3	0	0
40-49 y.	10	1	0	6	1	1	1
50-59 y.	15	0	2	4	5	3	1
60-70 y.	11	1	2	2	2	1	3
Total	50	2	8	17	12	5	6

Table 3: Distribution of cases regarding the type of the renal cystic disease

Type of renal cystic disease	Total number and percent.		Male		Female	
	Number	Percent.	Number	Percent.	Number	Percent.
CSRC	16	32%	8	50%	8	50%
MSRC	9	18%	4	44%	5	56%
ARPKD	3	6%	2	67%	1	33%
ADPKD	4	8%	1	25%	3	75%
Renal cyst (TS)	1	2%	0	-	1	100%
Parapelvic cyst	7	14%	2	28%	5	72%
Angiomyolipoma	3	6%	1	33%	2	66%
ACD	1	2%	1	100%	0	-
Complicated cyst	2	4%	1	50%	1	50%
MCD	2	4%	0	-	2	100%
MCDK	1	2%	1	100%	0	-
RCC(malign.cyst)	1	2%	1	100%	0	-

Table 4: Distribution of the cystic lesions regarding renal location

Type of renal cystic disease	Total		Left kidney		Right kidney		Both kidneys	
	No.	Perc.	No.	Perc.	No.	Perc.	No.	Perc.
CSRC	16	32%	6	12%	8	16%	2	4%
MSRC	9	18%	1	2%	4	8%	4	8%
ARPKD	3	6%	0	-	1	2%	2	4%
ADPKD	4	8%	2	4%	0	-	2	4%

Renal cyst (TS)	1	2%	1	2%	0	-	0	-
Parapelvic cyst	7	14%	5	10%	1	2%	1	2%
Angiomyolipoma	3	6%	2	4%	1	2%	0	-
ACD	1	2%	0	-	0	-	1	2%
Complicated cyst	2	4%	0	-	1	2%	1	2%
MCD	2	4%	0	-	0	-	2	4%
MCDK	1	2%	0	-	0	-	1	2%
RCC(malign.cyst)	1	2%	0	-	0	-	1	2%
Total	50	100%	17	34%	16	32%	17	34%

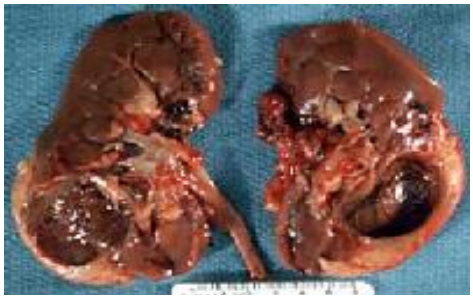

Fig.1: Nephrectomy specimen from a patient with a large benign simple cyst.

Fig.2: Cut surface of a nephrectomy specimen from a patient with ADPKD

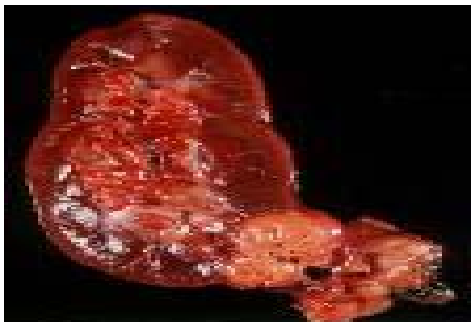

Fig.3: Cut section of nephrectomy specimen demonstrating (RCC), with an adjacent simple cyst.

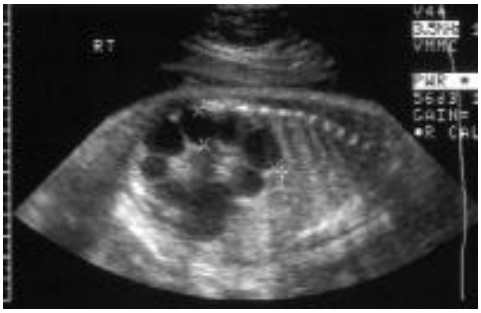

Fig.4: Prenatal sonogram of a fetus with a multicystic dysplastic kidney. The right kidney is large multicystic paraspinal mass.

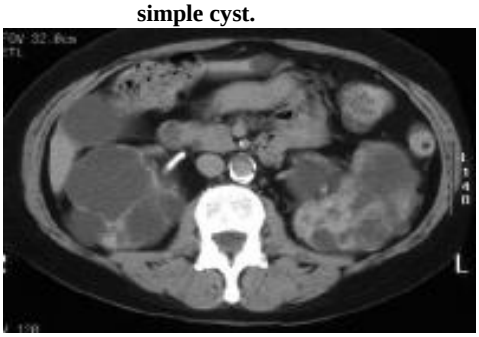

Fig.5: CT examination of the abd. 70-year-old woman with ADPKD .The kidneys are bilaterally enlarged .

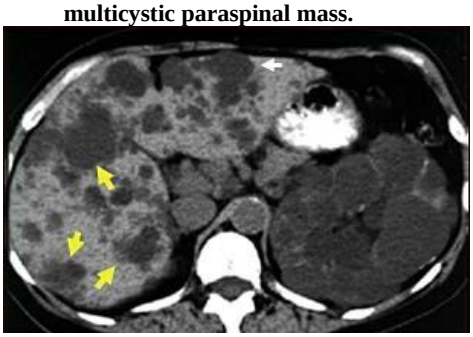

Fig. 6 : CT of 70 years old woman with ADPKD with multiple hepatic cysts

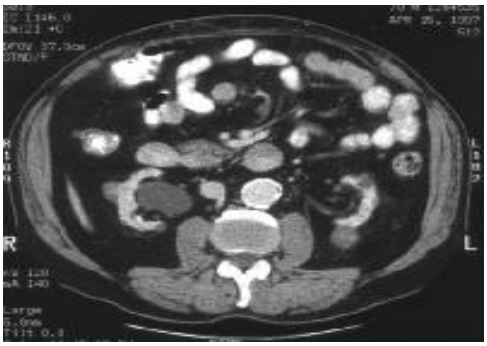

Fig. 7: CT scan demonstrates (ARCD) in a 70-year-old man who is dialysis-dependent. The CT scan demonstrates bilateral atrophic kidneys with multiple renal cysts.

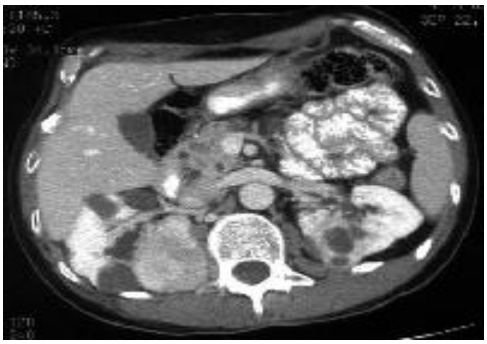

Fig. 8: A CT scan of a 38-year-old man with (VHLS). CT scan demonstrates multiple cysts in the kidneys and pancreas and solid renal lesions suggestive of malignancy.

DISCUSSION:

The renal cysts are frequent incidental finding in the adult especially above 50 years old and may be located any where in the parenchyma, they may be exophytic or parapelvic, the simple renal cyst with attenuation value 0-20 HU, the increasing the internal content density value may be due to iron content which indicating the hemorrhagic complicated renal cyst. The CT imaging of renal cyst is mainly indicated for documentation of the followings: the dissemination of the cystic lesion, confirm the diagnosis (by other modality like ultrasound) and associated features and diseases, and to exclude the complicated situations and malignant changes. In this study we found the most affected age group was 50-60 years old where 15 patients of the total 50 patients found to have renal cysts which confirm the findings of correspond studies like polycystic kidney disease by Wilson P.D. This confirm that the renal cystic lesions probability increasing with aging and they are most commonly present at fourth- sixth decades of life [14]. 56% of our cases were females (28 of 50 patients) and 44% were males (22 patients),so the Iraqi females were more affected than the males . the most common clinical presentation was flank pain followed by UTI and hematuria . The renal cysts were of variable attenuation values, the simple renal cyst have an attenuation value -5-20 HU. Simple, intermediate, and suspicious renal cysts: If the CT identification of a simple cyst is equivocal, observe the cyst with repeat scans. Debris may produce heterogeneous cyst attenuation, and cysts may have fluid-fluid levels from hemorrhage. Hemorrhagic cysts demonstrate unenhanced CT attenuation values of 40-100 Hounsfield units (HU). Calcification may be observed in the cyst walls or in the parenchyma between cysts, and nephrocalcinosis or nephrolithiasis is observed in as many as 50% of patients. Calcification likelihood increases with age and is fairly common in patients older than 50 years.

For Bosniak category IIF lesions, perform contrast-enhanced renal CT scan studies in 6 months and annually thereafter for at least 5 years.

A non-cystic mass that lacks the fat of a typical angiomyolipoma or an enlarging cyst may suggest carcinoma. Cystic renal lesion that contain thick internal septation, thick mural calcification, or enhancing mural nodules are suggestive of renal cell carcinoma and should be excised [15]. The left kidney is involved in 34% of cases while the right kidney is involved in 32% of cases and both kidney were involved in 34% of cases. In our study we found the cystic size was in correlation with the patient's age and we see the large cysts usually seen at age 50-60 years old and the small cysts are usually seen at age 20-30 years old this in agreement with findings of Madewell JE, et al [16].

CONCLUSION AND RECOMMENDATION:

The spiral CT scan is of valuable importance and informative imaging modality of the renal cystic lesion composition because the renal cysts are of variable attenuation values, the simple renal cyst have an attenuation value -5-20 HU. Debris may produce increased heterogeneous cystic content attenuation. Hemorrhagic cysts demonstrate un-enhanced CT attenuation values of 40-100 Hounsfield units (HU). Calcification may be observed in the cyst walls. Calcification likelihood increases with age and is fairly common in patients older than 50 years.

A non-cystic mass that lacks the fat of a typical angiomyolipoma or an enlarging cyst may suggest carcinoma. Cystic renal lesion that contain thick internal septation, thick mural calcification, or enhancing mural nodules are suggestive of renal cell carcinoma and should be excised.

Patients with autosomal dominant polycystic kidney disease (ADPKD) should be screened for intracranial saccular aneurysms with magnetic resonance angiography (MRA) or CT scan.

Acquired renal cystic disease (ARCD):

Screen patients with chronic renal failure for acquired cystic disease because of the associated risk of renal cell carcinoma (RCC). Initial ultrasound or CT scan screening may be performed after 3 years of dialysis and is repeated every 1-2 years thereafter. In patients with ARCD, contrast-enhanced CT scan can be performed annually to screen for carcinoma. This screening may be most valuable in younger patients and in patients with large cysts. Von Hippel-Lindau syndrome (VHLS): In patients with multiple cysts, perform CT scan or MRI every 1-3 years to monitor for RCC. Avoid instrumentation of the lower urinary tract in patients with cystic renal diseases who have increased susceptibility to infection (ie, with autosomal dominant polycystic kidney disease [ADPKD], autosomal recessive polycystic kidney disease [ARPKD], medullary sponge kidney [MSK]). Cystic renal lesion that contain thick internal septation, thick mural calcification, or enhancing mural nodules are suggestive of renal cell carcinoma and should be excised.

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