Medical Science

Study of renal disease using computed tomography in Taif, Saudi Arabia

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ABSTRACT

Background: Wide variable modalities and imaging techniques are used in the diagnosis of several urinary tract diseases. The availability, ease of acquisition, and diagnostic capability of CT are such that it remains the modality of choice when it comes to evaluate urinary tract diseases. *Aims:* To study renal disease using computed tomography at Taif, Saudi Arabia, and to determine the relationship between the CT finding and the patient's gender, age, and clinical finding. *Methods:* This is a retrospective study that was conducted at King Abdul Aziz Specialist Hospital in Taif from January 2022 to April 2022. Targeting patients who are presenting with flank pain, hematuria, polyuria, oliguria, and fever who were evaluated by MDCT scan. Statistics are analyzed using the statistical package for social science (SPSS). *Results:* A total of 50 participants were included in the current study, 25 (50%) of them were males, and most of them (22%) were within the age group of (29-38) years old. CT scan revealed stones in 21 (42%) of the participants, and cysts in 8 (16%). The most reported site of the pathology was found to be the left side as it dominates in about 15 (40.5%) of participants. *Conclusion:* The most abnormal findings reported on the CT scan were renal stones and renal cysts. The most common presenting symptom of renal stones was found to be flank pain and the most reported site of the pathology was in the kidney. The left side was to be found the most reported site of the pathology. Age was found to be significantly associated with pathology found in CT with stones. Males are more affected by stones than females. Researchers recommended that CT scan is better for renal pathology.

Keywords: Renal diseases, Computed tomography, Saudi Arabia

1. INTRODUCTION

The kidneys, ureters, bladder and urethra make up the urinary tract, often known as the renal tract or urinary system. The urinary system's functions include blood PH regulation, blood volume and blood pressure regulation, waste elimination and metabolite and electrolyte control. Once the urine is produced, it is removed from the body by the urinary system (Alshoabi et al., 2020). The kidneys receive a large amount of blood through the renal arteries

and the renal vein drains the blood from the kidneys. Each kidney is made up of functioning elements called nephrons. Both kidneys filter 120 to 150 quarts of blood daily to remove wastes and maintain fluid balance. In a healthy individual, this procedure results in approximately 800-2000 milliliters (mL) of urine produced daily. Depending on fluid consumption and renal function, this amount varies. Subsequent blood filtration and additional processing, urine exit the kidney through the ureters, which direct the urine to the bladder where it is stored and then emerges outside the body via the urethra to the outside of the body by urination. The urinary system is very similar between male and females, only the length of the urethra is different between them (Smith et al., 1995).

Several modalities are used in diagnosing urinary tract diseases, like conventional x-ray, computerized tomography (CT), magnetic resonance imaging (MRI), ultrasound and nuclear medicine. When evaluating disorders of the urinary system, CT is the preferred modality, due to its availability, ease of acquisition and diagnostic capability (El-Ghar et al., 2021). In CT, a narrow beam of x-rays is focused on the body and rotated rapidly around it, producing images that are processed by the computer to generate cross-sectional slices of the body. Tomographic images contain more detail than conventional x-rays and are called tomographic slices. A CT scan allows imaging of an entire organ or body in less than 20 seconds with a sub-millimeter resolution. It is possible to perform CT scans with or without contrast material. Contrast material is defined as a substance taken orally or given intravenously (IV) that enables an organ or tissue under study to be seen more clearly (Hagen-Ansert, 2018).

Patients with particular renal pathologies may present with unclear clinical signs. It is helpful to know a patient's history of infections, prior urinary system problems (renal stones), high blood pressure, or family history of the renal cystic disease. There are a few common symptoms associated with renal infection or disease: Flank pain, hematuria, polyuria, oliguria, fever, constipation, weight loss, or generalized swelling (Prasad & Patel, 2018).

CT scan delivers numerous advantages over the other modalities, such as detection of very small stones, sensitivity for radiolucent calculi and identification of other reasons for flank pain as well as infections, cysts, obstructions, traumatic injuries and tumors. Low or ultra-low-dosage CT scans can be used to image urinary stone disease while avoiding any pre-procedure preparation. Plain abdominal radiograph has been replaced by non-contrast helical CT, as a gold standard in the diagnosis of nephrolithiasis (Brisbane et al., 2016). The purpose of this study was to study renal disease using computed tomography at Taif, Saudi Arabia and to determine the relationship between the CT finding and the patient's gender, age and clinical finding.

2. MATERIALS AND METHODS
This is a retrospective study that was conducted at King Abdulaziz Specialist Hospital in Taif.

Materials
Study population
The study of 50 patients including males and females of different ages who presented with flank pain or hematuria were evaluated by MDCT scan.

Inclusion criteria
Any patient with flank pain, hematuria, polyuria, oliguria, fever, with no age or sex predilection

Exclusion criteria
Our study excluded patients having a history of intravenous contrast agent allergies, those with abnormal kidney function tests, those who had recently undergone surgery and women who were pregnant.

Study duration
The study was conducted from January 2022 to April 2022.

Methods
A total number of 50 patients who are presenting with flank pain or hematuria were evaluated by MDCT scan.

CT Examination
The CT images were conducted using Multi-detector CT scanner. The scan parameters (1.5 pitch, 200MA, 120 KV, thin section 5mm or less). Features of CT scanner: Largest couch capacity is 180 kg CT machine in King Abdulaziz Specialist hospital.

CT renal technique

The patient lays supine on the CT scanner couch, arm beside the body or elevated above the head, topogram view is obtained regularly in AP projection. None contrast images of the kidney are obtained to demonstrate calcifications and density of kidney masses followed by dynamic IV contrast-enhanced images with a thin slice through the kidneys, extending through the abdomen. Commonly the pelvis is also imaged to see the entire urinary tract and look for adenopathy (enlargement of lymph node).

Because scanning is so fast, dynamic images of kidneys show the arterial phase of enhancement, making it use full to obtain a third set of images through kidneys to better asses of the parenchyma. Exception in transitional carcinoma the exam is extended in to the pelvis with delayed views of the bladder 3–6-minute delay images.

Data Analysis

All images were interpreted on the computer workstation by expert radiologist and the diagnosis was established, then statistical analysis is done using statistical Program for Social Science (SPSS) version 23.

3. RESULTS

The total number of participants was 50, 25 (50%) of them were males and the other 25 (50%) were females. The mean age was found to be 46.8 ± SD = 18.82 (range from 18 to 88). Regarding age groups of participants most of them (22%) were within the age group of (29-38), then age groups of (39-49) and (49-58) each represented by 9 (18%), then the age group of (18–28) which consisting of 8 (16%) of them, the age group of (59– 68) by 6 (12%), age group of (69–78) which includes 4 (8%) of participants and finally (79–88) which consists of only 3 comprising (6%) (Table 1).

Table 1 Socio-demographic characteristics (n=50)

Variable	Frequency	Percentage
Gender		
Female	25	50%
Male	25	50%
Age groups		
18 – 28	8	16%
29 – 38	11	22%
39 – 48	9	18%
49 – 58	9	18%
59 - 68	6	12%
69 – 78	4	8%
79 - 88	3	6%

Some patients have combined pathology either on the same or different site; stones/cyst (2%), stone/hydroureter (2%), stone/calcification (2%), stone hydronephrosis (4%) and stone/hydroureteronephrosis (2%) on the same side. Also, stone/prostatic calcification (2%), cyst/CKD (2%), stone in ectopic kidney (2%). 1 (2%) patient have stones both in the right and left kidney. CT findings were found to be normal in 11 (22%) of participants, CT scan revealed stones in 21 (42%) of participants, cyst in 8 (16%), ureteric stent/hydronephrosis in 1 (2%), atrophy in 2 (4%), mass in 5 (10%), recurrent UTI in 1 (2%) and also single kidney in 1 (2%) of participants (Table 2).

Table 2 CT findings

CT findings	Frequency	Percentage
Normal	11	22%
Stones	21	42%
Cyst	8	16%
Ureteric stent/hydronephrosis	1	2%
Atrophy	2	4%
Mass	5	10%
Recurrent UTI	1	2%

Single kidney	1	2%

Flank pain was the most reported symptom by most of the participants (52%) followed by hematuria (8%), itch skin (2%), edema (2%) and poor appetite (4%) (Table 3).

Table 3 Presenting symptoms.

Symptoms	Frequency	Percentage
Flank pain	24	52%
Hematuria	4	8%
Itch skin	1	2%
Edema	1	2%
Poor appetite	2	4%

The site of the pathology was found to be in the kidney in about 24 (63.2%) of participants, ureteric abnormalities were found in about 11 (28%) of participants, adrenal gland pathology in 2 (5.3%) and bladder abnormalities 1 (2.6%) of participants (Figure 1).


Figure 1 Site of pathology

The most reported side of renal disease was found to be the left side as it dominates in about 15 (40.5%) of participants followed by the right-side pathologies were found in about 14 (37.8%) and bilateral abnormalities were found in 8 (21.6%) of participants (Figure 2).

Association between CT finding with patient age, gender, clinical finding
Age significantly associated with pathology found in CT (P value = .038). Stones were significantly the most reported CT abnormality, more frequently found in the age group 29–38 years. Left side renal disease are more common in the age group of (28–38) years old, whereas the right sided renal disease is predominant with in the age group of (49–58) (P value = .432). Flank pain also significantly present in those within the age group 49–58 years (P value = .047). Poor appetite is less likely to be the presenting symptoms in all age groups (P value = .044). More information is provided in Table 4.

Stones more frequently found in males than female (62% vs. 38%). Cyst more frequently found in females (75%) than males (25%). But this difference is not statistically significant (P value = .074). No significant difference between males and females in site of pathology (P value = .446), but the kidney more frequently involved in male than female and ureter more frequently involved in female. Gender and age don't affect the Laterality (P value = .228). More information is provided in Table 5.
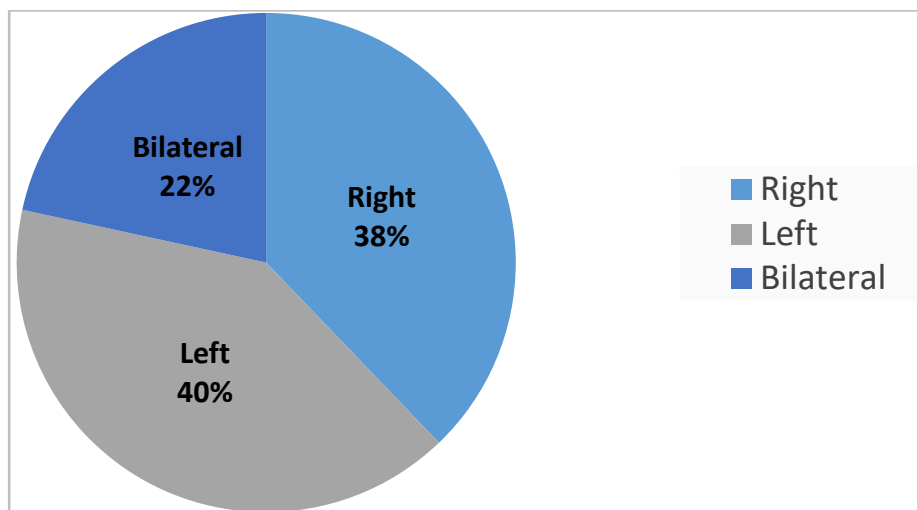
Figure 2 Laterality of the pathology

Table 4 Association between age and CT findings, laterality and symptoms

Variable	Age groups							P value
CT findings	18 – 28	29 - 38	39 – 48	49 - 58	59 - 68	69 - 78	79 - 88	.038
Stones	3 (14%)	6 (28.5%)	2 (9.5%)	4 (19%)	4 (19%)	2 (9.5%)	0 (0%)	
Cyst	0 (0%)	0 (0%)	0 (0%)	2 (25%)	1 (12.5%)	2 (25%)	3 (37.5%)	
Normal	4 (36%)	2 (18%)	3 (27%)	1 (9%)	1 (9%)	0 (0%)	0 (0%)	
Ureteric stent/hydronephrosis	0 (0%)	0 (0%)	0 (0%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	
Atrophy	0 (0%)	2 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Mass	1 (20%)	0 (0%)	3 (60%)	1 (20%)	0 (0%)	0 (0%)	0 (0%)	
Recurrent UTI	0 (0%)	0 (0%)	1 (100%0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Single Kidney	0 (0%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Laterality								
Right	2 (14%)	0 (0%)	3 (21.4%)	5 (35.7%)	2 (14%)	1 (7%)	1 (7%)	.432
Left	2 (13.3%)	6 (40%)	1 (6.6%)	2 (13.3%)	2 (13.3%)	1 (6.6%)	1 (6.6%)	
Bilateral	0 (0%)	3 (37.5%)	0 (0%)	1 (12.5%)	1 (12.5%)	2 (25%)	1 (12.5%)	
Flank pain								
Yes	6 (25%)	8 (33.3%)	4 (16.6%)	3 (12.55)	1 (4%)	0 (0%)	2 (8%)	.047
No	2 (7.6%)	3 (11.5%)	5 (19%)	6 (23%)	5 (19%)	4 (15.3%)	1 (4%)	
Poor appetite								
Yes	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (50%)	0 (0%)	1 (50%)	.044
No	8 (16.6%)	11 (23%)	9 (18.8%)	9 (18.8%)	5 (10.4%)	4 (8.3%)	2 (4%)	

Table 5 Association between gender, CT findings and laterality

Variable	Gender		P value
	Female	Male	
CT findings			
Stones	8 (38%)	13 (62%)	
Cyst	2 (25%)	6 (75%)	
Normal	9 (82%)	2 (18%)	
Ureteric stent/hydronephrosis	1 (100%)	0 (0%)	.074
Atrophy	1 (50%)	1 (50%)	
Mass	2 (40%)	3 (60%0	
Recurrent UTI	1 (100%)	0 (0%)	

Single kidney	1 (100%)	0 (0%)	
Site of pathology			
Kidney	9 (37.5%)	15 (62.5%)	
Ureter	6 (54.5%)	5 (45.5%)	.446
Bladder	0 (0%)	1 (100%)	
Adrenal gland	0 (0%0	2 (100%)	
Laterality			
Right	6 (43%)	8 (47%)	
Left	6 (40%)	9 (60%)	.228
Bilateral	3 (37.5%)	5 (62.5%)	

Stones more frequently present in the left side (42.8%) and cyst more frequently in the right side (50%). But this difference is not statistically significant (P value = .507). CT abnormality significantly have tropism to certain locations (P value = .002) with stones almost always found in kidney (52%) and ureter (48%) and cyst always found in the kidney (100%). More information is provided in Table 6.

Table 6 Association between CT findings and laterality and site of pathology

Variable				CT findings				P value
	Stones	Cyst	Normal	Stent/hydronephrosis	Atrophy	Mass	Laterality	
Laterality								
Right	6 (28.5%)	4 (50%)	0 (0%)	1 (100%)	0 (0%)	3 (75%)	0 (0%)	
Left	9 (43%)	2 (25%)	0 (0%)	0 (0%)	2 (100%)	1 (25%)	1 (100%)	.507
Bilateral	6 (28.5%)	2 (25%)	0 (0%0	0 (0%)	0 (0%)	0 (0%)	0 (0%0	
Site of pathology								
Kidney	11	8 (100%)	0 (0%)	0 (0%)	2 (100%)	2 (40%)	1 (100%)	
Ureter	10	0 (0%)	0 (0%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	.002
Bladder	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (20%)	0 (0%)	
Adrenal gland	0	0 (0%)	0 (0%)	0 (0%)	0 (0%)	2 (40%)	0 (0%)	

CASE 1 CT KUB Male patient, age 41, with right renal stone

CT Finding CT KUB image displays right upper renal stone measuring 8 x 3 mm with HU 350 (labeled with yellow arrow). Right mild hydronephrosis with mildly dilated right ureter.

CASE 2 Male patient, age 19, Post open pyelolithotomy
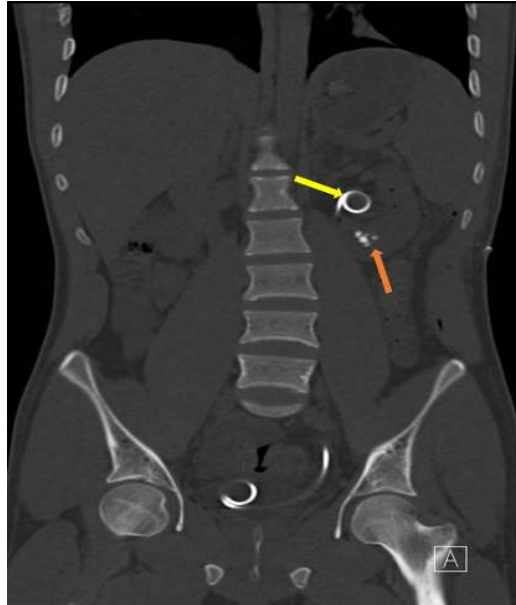
CT finding CT KUB image displays Left kidney: Normal size and shape, fullness/mild hydronephrosis with multiple amalgamated stones in the lower calyces (labeled with brown arrow). Mild left peri-renal fat stranding and double J stent reaching the renal pelvis (labeled with yellow arrow).

4. DISCUSSION

CT imaging is considered an important diagnostic technique for renal stones and its results initial step in deciding the most appropriate treatment of choice for the management of renal stones as it determines the exact site, size and in some cases type of renal stone. Non-contrast CT scan for the abdomen and pelvis represents an accurate diagnostic tool but one of its drawbacks was the predisposition of patients to ionizing radiation (Kambadakone et al., 2015).

In this study half of the participants were males and the other half were females most of them were within the age group between thirty- and forty-years-old mean with a mean age of 46.8 ± SD = 18.82 years old. Regarding CT findings in the current study; about one-fifth of participants had normal CT scan results, but in about less than half of the participants CT scan revealed stones this finding was close to other estimated prevalence finding in the congruent study conducted by Andrabi et al., (2015) which showing fifty percent prevalence (Terada et al., 2008). Cysts were found in less than one-fifth of the patients and this was found to be a lower percentage when compared to other studies showing a prevalence of renal cysts detected by CT scan reaching one-third of participants (Carrim & Murchison, 2003; Ganesan et al., 2017). Renal mass was reported in ten percent of participants, similar results were revealed by a parallel study conducted by them showing ten percent of participants were having renal mass in CT scan (Khan et al., 2016).

Hydronephrosis, kidney atrophy, recurrent UTI and also single kidney were the least reported findings with less than two percent of participants. Much lower percentage of patients in the current study have combined pathology either on the same or different site; stones and cyst, stone and hydro ureter, stone and calcification, stone and hydronephrosis and stone and hydroureteronephrosis on the same side. Also, stone and prostatic calcification, cyst and chronic kidney disease, stone in ectopic kidney and stones both in the right and left kidney all these previously mentioned combined pathologies reported on CT scan were only found in two percent of participants for each combination, double pathology was also present and described in a study conducted by Khan et al., (2016). In about two-thirds of participants; the most commonly reported site of renal pathology was found to be the kidney, about less than one-third of participants were found to be having ureteric abnormalities, bladder abnormalities were the least reported with only two percent of participants, these findings were consistent with the findings revealed by them, study showing kidney abnormalities in more than half of the participants followed by ureteric and urinary bladder abnormalities (Chand et al., 2013).

Regarding the stone's side, the left side's pathology was the most frequently reported side in about two-fifths of participants followed by the right-side pathologies is about more than one-third of patients and bilateral abnormalities were found in one-fifth of participants, these results were contradictory to the results revealed in the study conducted by them showing no difference

between the right and left side (Alshoabi et al., 2020). Concerning the most reported symptoms of stones; flank pain was reported by more than half of the participants followed by hematuria, these findings were agreed on and augmented by another study conducted by them as flank pain was the most documented symptom among participants (Kim et al., 2019).

Age was found to be significantly associated with pathology found in CT with stones the most reported CT abnormality and it is more frequently found in the age group 29–38 years, this was closely similar to the finding reported in the study done by them showing forty years as the most common age at which renal stone symptoms develop. Flank pain is significantly present in those within the age group 49–58 years, in contradiction to the study carried on by them showing a decreased appearance of symptoms with an increase in age (Krambeck et al., 2013). Kidney stones were found to be more common in males than females. Cysts were more frequently found in females than males. But this difference is not statistically significant. No significant gender-based difference between males and females, but kidney was more frequently involved in males than females and the ureter more frequently involved in females and this was consistent with the studies carried on by (Strope et al., 2010) and also (Chien et al., 2021).

5. CONCLUSION

The study revealed that a CT is an effective modality that can confirm patients' clinical disorders for renal system diseases. The most reported CT scan abnormalities were renal stones and renal cysts. Combined pathology was found in less than five percent of participants, the most reported presenting symptom of renal stones was found to be flank pain and the most common site of the pathology was in the kidney. The most reported site of the pathology was found to be the left side. Age was found to be significantly associated with pathology found in CT with stones most reported in the age group between thirty and forty years old. Males are affected by stones more frequently than females. No significant gender-based difference between males and females.

Ethical approval
This study was approved by the Directorate of Health Affairs, Taif, Health committee no KACST, KSA: HAP-02-T-065, approved No: 507

Informed Consent Statement
The study was retrospective, hence the requirement for written informed consent was not required.

Conflict of interest
The authors declare that there is no conflict of interests.

Data and materials availability
All data sets collected during this study are available upon reasonable request from the corresponding author.

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