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Diagnostic Validity Of Low Dose CT KUB In Demonstration Of Genitourinary Tract Calculi Compared To Normal Dose Ct Kub: A Provisional Study

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Abstract

Objective: Renal colic is a commonly encountered clinical presentation. Our objective is to evaluate the accurate diagnostic yield of low-dose CT KUB for the detection of urinary calculi, to minimize radiation dose to the patients, and to analyze the diagnostic accuracy of low-dose CT KUB when compared to regular dose CT KUB. We speculate the low dose CT-KUB may reduce patient radiation dose while maintaining diagnostic value.

Materials and Methods: This comparative cross-sectional validation study was conducted at the Department of Radiology in Benazir Bhutto Hospital, Rawalpindi June 2021 to Feb 2022. After approval of the hospital's ethical committee, a sample of 49 kidneys of 31 patients was collected by non-probability consecutive sampling technique. Included were the patients diagnosed with renal calculi referred from other departments. All the included patients were scanned by Toshiba Aquilion 16 slices, using automated tube current modulation, without any oral or IV contrast. CT scan started from the diaphragm down to pubic symphysis with standard-dose CT (SDCT) followed by low-dose CT (LDCT). After the data was recorded, a statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA) was used to analyse the data and generate results. Mean + standard deviation was calculated for qualitative data while frequency and percentage for qualitative variables. The means were compared by independent sample t-test while the agreement between standard and low dose was depicted by kappa value.

Results: A total number of 49 kidneys of 31 persons having renal stones was added to the study. The mean age of the included patients ranges from years 27 to years 48 with a mean age of years 36.42 + 9.97. In gender distribution, 75.5 % (37) were male while 24.5 % (12) were females. More than half 59 % (29) were right while 41 % (20) were left kidneys.

Conclusion: Our study demonstrated that LOW DOSE CT KUB was a productive and efficient modality in the diagnosis of urothelial stones despite considerably reduced radiation dose and exposure as seen in standard dose CT KUB.

Keywords: Urolithiasis, ALARA, low dose CT KUB, stone density.

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1. Introduction

Renal colic is a commonly encountered clinical presentation. The incidence of renal calculi has increased over the last few decades which may be partly attributed to improving detection however changes in diet and lifestyle with increasing levels of obesity are also responsible [1]. Urinary stones are mostly asymptomatic within the renal calyces however passage into the ureter obstructs the flow of urine with upstream hydro-nephro-ureter resulting in colic-type pain. [2]

X-ray (KUB), ultrasound, or a combination of both are in routine use as an initial workup for renal colic. [3] Non-contrasted CT of the urinary system (CT KUB) is the investigation of choice for renal pain. [5] It is further required for treatment planning, in addition to the 40–60% of cases where calculi are not visible on X-ray KUB. CT KUB does not only detect stones but also determines their size, number, and location. [3] Current improvements offer further radiation dose trimming with ultra-low dose and low-dose CTKUB technique in the detection of urolithiasis. [4] MRI can be used to diagnose the effects of obstruction in the urinary system caused by calculi but is not a preferable diagnostic technique. [6] Keeping the ALARA principle (As Low As Reasonably Achievable) in view, reducing the dose of radiation for suspected renal colic is beneficial. In this regard, many studies show that it is possible to detect renal calculi with low-dose CT scans. [7] Further, Ultra low dose CT and Low dose CT are effective techniques with high diagnostic yield in the detection of urolithiasis. [8]

Current LD CT studies with the iterative reconstruction offer sub-millisievert dose protocols in the evaluation of urolithiasis with no significant decrease in diagnostic accuracy. [9] LDCT provides almost equivalent accuracy with a considerably reduced radiation dose in comparison to standard dose CT [10]. The limitation compared to standard-dose CT KUB is in detecting stones which are <3 mm in size as well as in persons who have a body mass index of >30 kg/m2.[8] Moreover, LDCT KUB also reduces the relative scope for making any extra-renal diagnoses.[3]

An ultra-low dose CT is helpful in follow-up cases of ureteral stones. [11] The rationale of conducting the current study is to assess the diagnostic yield of low-dose Computed Tomography KUB for urinary stones diagnosis in our population.

2. Materials & Methods

This comparative cross-sectional validation study was conducted at the Department of Radiology in Benazir Bhutto Hospital, Rawalpindi June 2021 to Feb 2022. After approval of the hospital's ethical committee, a sample of 49 kidneys of 31 patients was collected by non-probability consecutive sampling technique.

Included were the patients diagnosed with renal calculi referred from other departments. All the included patients were scanned by Toshiba Aquilion 16 slices, using automated tube current modulation, without any oral or IV contrast. CT scan started from the diaphragm down to pubic symphysis with standard-dose CT (SDCT) followed by low-dose CT (LDCT). In SDCT KUB, a tube voltage of 120 kV and tube current-time product of 240 mAs were given while in LDCT KUB, a tube voltage of 90 kV and a tube current-time product of 110 mAs will be given.

The SDCT and LDCT findings were interpreted by one consultant radiologist (with at least 3 years of post-fellowship experience). These findings were compared for the number, size and density of detected urothelial stones.

Statistical analysis:

After the data was recorded, a statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA) was used to analyse the data and generate results. Mean $\pm$ standard deviation was calculated for qualitative data while frequency and percentage for qualitative variables. The means were compared by independent sample t-test while the agreement between standard and low dose was depicted by kappa value. A value of 0 – 0.20 indicates slight agreement; 0.21– 0.40, fair agreement; 0.41– 0.60, moderate agreement; 0.61–0.80, substantial agreement; and 0.81–1.00, almost perfect agreement. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, a P-value <0.05 was considered significant.

3. Results

A total number of 49 kidneys of 31 cases/persons with renal stones was added in this study.

The mean age of the patients ranges from years 27 to years 48 with a mean of years 36.42 $\pm$ 9.97. In gender distribution, 75.5 % (37) were male while 24.5 % (12) were females. More than half 59 % (29) were right while 41 % (20) were left kidneys. The distribution of renal stones as per location is depicted in Table 1. The mean $\pm$ standard deviation of stone diameter and stone density (HU value) with the two modalities is given in Table 2. It shows a statistically insignificant difference between low dose and standard dose as >0.05 is the p-value. The kappa test, which compares the stone detection by two modalities is given in Table 3 while Fig 1, shows the detection of stones by low and standard doses based on size.

Table 1. Shows the distribution of stone as per location

Location of stones (n = 49)		
RENAL	Pelvis	10 (20.4%)
38 (77.55%)	UPPERPOLE	6 (12.2%)
	LOWERPOLE	10 (20.4%)
	MIDSOLE	5 (10.2%)
	INTERPOLE	3 (6.12%)
	PUJ	4 (8.16%)
URETER		6 (12.2%)
VUJ		5 (10.2%)

Table 2 Comparison of mean by t-test reveals a statistically insignificant difference between standard dose and low dose.

	Mean + standard deviation		
Variables	standard	Low dose	P value
Stone diameter mm	10.22+6.24	9.11+6.4	0.387
Density HU	708 +424	686 +437	0.801

Table 3 Kappa test, comparing the stone size with standard dose and low dose. Statistically, there is significant agreement between the two modalities with the kappa value of 0.468.

Stone size in (mm)	Standard	Low Dose
< 3	4	3
3-5	9	8
6-10	16	17
11 – 15	9	6
16 - 20	6	8
> 20	5	2
Kappa Test	0.468	
P – value	0.001	

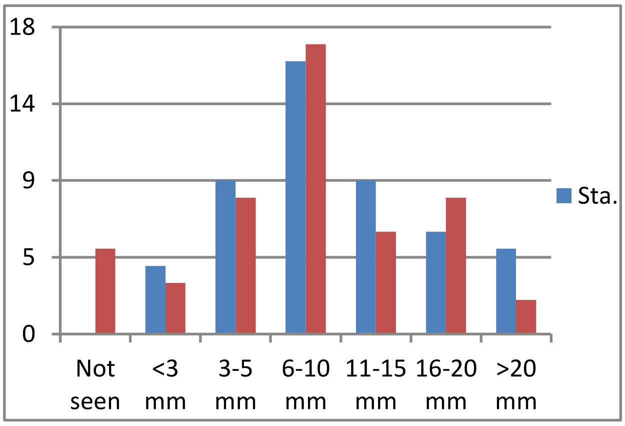

Figure 1 shows the detection of stones by low dose and standard dose based on the size of the stone.

5. Discussion

In a patient presenting with suspected acute renal colic, radiological investigation is crucial in diagnosing the cause of the condition. The selection of radiological imaging is important, for the diagnosis of renal or ureteric calculi as well as for the management and effective care strategy for individuals presenting with this problem. The accuracy, availability, safety, cost-effectiveness, and reproducibility of interpretation of the imaging modality should all be kept in mind when going for an imaging investigation. [21] CT scan of the urinary tract is a major investigation to study the diseases of the Genitourinary system. NCCT is a time-saving examination without any Intravenous contrast administration. NCCT is not only helpful investigation of suspected renal diseases but also in the diagnosis of any other diseases that clinically mimic renal colic. Owing to the considerable contrast difference between the majority of renal calculi and soft tissues in the abdominal cavity, many researchers have suggested low-dose CT scan techniques in possible cases of renal diseases causing pain. [16]

CT scan for the urinary tract (CT-KUB) is the investigation of choice for the demonstration of renal and ureteral calculi. [17] The CT scan for the urinary tract is superior to sonography and radiography as it is further beneficial for more accurate anatomic details; and location of calculi particularly in the ureteric tract in which calculi are mostly masked by the gases in gut loops. [20] Along with the advantages of CT, the additional disadvantage is radiation exposure posing considerable risk. [13] Increased levels of computed tomography (CT) scan-produced radiation doses are statistically proven to cause carcinomas for >100 mSv effective doses (and >50 mSvs as well as seen in some other research). [19]

Recent advances in CT have been greatly helpful for the diagnosis of urolithiasis however due to the increasing frequency and rate of recurrence of renal tract stones, grey scale sonography is not the imaging modality of choice in comparison to CT scan KUB for demonstration and evaluation of urinary tract stones. [14] Repeated hospital visits may occur in many of the patients with renal area pain, requiring radiological investigations recurrently, it should be a matter of concern that collective dose due to radiation exposure must remain within permissible limits. The use of sub millisievert (sub-mSv) CT for stone detection and follow-up can reduce radiation dose in comparison to standard dose kidney, ureter, and bladder (KUB) CT. [15] If a CT scan is required for repeat study, it must be accommodated with minimum radiation exposure while getting reliable diagnostic information keeping the As Low As Reasonably Achievable i.e.; ALARA principle, in mind. [1] Ultra-low dose CTKUB examination of renal stones is considerably accurate in repeat cases, which offers radiation-absorbable doses equivalent to plain X-rays as well as less than background radiation absorbed per year. [18]

In our study, CT KUB demonstrated calculi with the presence or absence of additional signs of obstruction in a maximum number of patients. The mean age was (36.42 + 9.97), and the range of age was (27-48) years with 75.5 % (37) males and 24.5 % (12) females.

This study demonstrated that 77.55% of calculi were found in the kidney, while 12.2% of calculi were ureteric and 10.2% at VUJ.

In the current study, no considerable difference was seen in the size of the calculi when the comparison is made between the two procedures (p=0.387), agreeable with the results of A. Soliman., L. K Sakr [10] showed that there was no significant variation in the size of calculi when the comparison is made between the two procedures i.e.; low dose and standard dose CT KUB. No considerable variation in the HU values of calculi was seen in low-dose CT in comparison to that in standard-dose CT in our study.

5. Conclusion

A current study demonstrated that low-dose CT is a productive and efficient method in the diagnosis of urothelial stones despite considerably low radiation exposure and dose as observed in standard-dose CT.

CONFLICTS OF INTEREST- None

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Potential competing interests: None to report

Contributions:

H.H.M, F.B - Conception of study

H.H.M, F.B, H.R - Experimentation/Study Conduction

H.H.M, F.B, K.R - Analysis/Interpretation/Discussion

H.H.M, H.R, K.Z, F.A - Manuscript Writing

H.H.M, K.R - Critical Review

H.H.M - Facilitation and Material analysis

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