



## Original Article

# Comparison of Low-Dose and Standard-Dose CT in Patients with Clinically Suspected Urolithiasis: A Prospective Study

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## Abstract

**Background:** *The prevalence and recurrence of urolithiasis are high; particularly in the north-western part of India. Ultrasonography has poor sensitivity and specificity compared to Non Contrast Computed Tomography (CT) for detection of both renal and ureteral calculi. Drawbacks of Non contrast CT include radiation exposure which can be overcome by low-dose CT protocols. Low-dose CT may be a useful investigation with high diagnostic accuracy and less radiation hazards in evaluating urolithiasis.*

**Aim:** *To compare efficacy of low-dose non contrast CT with standard-dose CT in the detection of urolithiasis*

**Material and Methods:** *Fifty cases of clinically suspected urolithiasis underwent both abdominal standard-dose CT (140 mAs) and low-dose CT (70 mAs) with fixed kVp (120). Patients with BMI <30 (non obese) were included in the study. Both the scans were independently reviewed by two radiologists for the characterization of urolithiasis and any indirect signs of renal and ureteral colic. Results for low-dose CT were compared with those obtained with standard-dose CT (reference standard).*

**Results:** *Majority of patients were seen in 3<sup>rd</sup> decade with male to female ratio of 1:8. Eighty Eight calculi were detected in 50 patients. Low-dose CT had approx. 82% and 100% sensitivity in identifying renal calculi <5mm and >5mm size respectively while it had approx. 92% sensitivity for the detection of ureteric calculi. Mean effective radiation dose in standard-dose CT and low-dose CT was 2.1 mSv and 4.3 mSv respectively.*

**Conclusions:** *Low-dose CT provides effective method of identifying and evaluating urolithiasis with high diagnostic accuracy and sensitivity and significant dose reduction as compared to standard-dose CT.*

## Introduction

Urolithiasis is a common pathology with the lifetime risk exceeding 12% in men and 6% in women<sup>[1]</sup>. In addition, recurrence rates are quite high with an estimated rate of 30% to 40% within

5 years 20<sup>[2]</sup>. The incidence, prevalence and recurrence of urolithiasis are very high; especially in the north-western part of India<sup>[3]</sup>.

Ultrasonography is an attractive investigation in evaluation of urolithiasis because it is less

expensive, universally available and non-invasive with lack of ionizing radiation<sup>[1]</sup>. However the results are limited due to its image obscuration by underlying bowel loops and bony structures<sup>[1]</sup>. Many studies have demonstrated decreased sensitivity and specificity of Ultrasonography as compared to Computed Tomography (CT) for detection of urolithiasis. CT is now recommended by numerous authors<sup>[4,5]</sup> as the initial diagnostic imaging technique in patients with suspected renal colic. Non-contrast CT is highly sensitive technique for stone detection. It can be performed rapidly and needs no intravenous iodinated contrast. Many studies have shown a high sensitivity and high specificity of non contrast CT for stone disease and alternative diagnoses are found in 10% to 24% of patients with acute flank pain<sup>[6]</sup>.

Many authors have reported that in the screening of patients with suspected renal colic, low-dose CT protocols can be employed which involve substantial reduction of tube current or increased pitch<sup>[7-10]</sup>. Low-dose CT can be performed in short time, does not require any bowel preparation and has lesser cost as compared to conventional CT<sup>[1]</sup>. It also provides accurate information regarding the stone size, location, density, direct and indirect signs of obstruction and even diagnosis of non-urolithiasis conditions<sup>[1]</sup>. Also low-dose CT may achieve sensitivities and specificities close to those reported for standard-dose CT in detecting ureteral stones<sup>[11,12]</sup>. The aim of our study is to compare low-dose CT (70 mAs) with standard-dose (140 mAs) non contrast CT for the detection of renal and ureteral calculi.

### Material and Methods

The study was conducted in a tertiary care centre in North West India. Clinically suspected patients of urolithiasis, referred from the urology department for Non contrast CT formed the material of the study. Pregnant females, children and obese patients (Body mass index >30) were excluded. CT was performed with 64 slice-MDCT scanner (Somatom Definition AS+ scanner from

Siemens Healthcare) without oral or intravenous contrast. Scan done from diaphragm to lower symphysis pubis with standard-dose CT (140 mAs) first followed by Low-Dose CT (70 mAs). Fixed tube voltage of 120 kVp was employed in both the scans. Multiplanar 2D and 3D reformatted images were generated on workstations from axial source images. Number, size and site of stones were recorded for both the scans and findings compared. Renal stones were classified according to size (<5 mm and >5 mm) and ureteral stones according to location (upper, middle and lower). Effective dose was calculated for each scan using DLP provided in the report by the manufacturer and multiplying it by constant (k) as prescribed by the European Commission Appendix C<sup>[13]</sup> and National Radiological Protection Board -W67<sup>[14]</sup>. Mean effective dose was also calculated for both the scans.

### Results

Fifty clinically suspected patients of urolithiasis formed the material of the study. Majority of the patients were seen in 3<sup>rd</sup> decade of life. Most of the patients were males with male to female ratio of 1:8. Total of 88 calculi were seen on standard-dose CT (64 in kidneys and 24 in ureters) (Table 1). Of 64 renal calculi, 22 were <5mm in size while 42 > 5 mm. Out of 22 renal calculi (< 5mm) detected on standard-dose CT, 18 were detected on low-dose CT and four were missed likely due to reduced quality of the image. The missed calculi were < 3mm in size on standard-dose CT. Also out of 42 renal calculi (> 5mm) detected on standard-dose CT, none was missed on low-dose CT and diagnosed correctly. So sensitivity of low-dose CT in identifying renal calculi > 5mm was 100% while for renal calculi < 5mm, it was approx. 82%.

24 ureteric calculi were identified in our study on standard-dose CT. Majority of them (66.7%) were seen in lower ureter. On low-dose CT, 22 ureteric calculi were accurately depicted as compared to standard-dose CT while 2 calculi were missed. The missed calculi were < 3 mm in diameter and

located adjacent to iliac crossing. Two phleboliths were over reported as ureteric calculi on low-dose CT. So sensitivity of low-dose CT in identifying ureteric calculi was approx. 92%.

Effective dose was calculated for all the patients at high and low mAs and mean effective dose calculated. Mean effective dose for standard-dose CT and low-dose CT were 4.3 mSv and 2.1 mSv respectively, implying >50% reduction in radiation dose to the patient.

**Table 1:** Distribution of Calculi (n=88)

Calculi	Standard-Dose CT	Low-Dose CT
Renal		
A) <5mm	22	18
B) >5mm	42	42
Ureteric	24	22
Total	88	82

## Discussion

Non contrast CT has become the standard imaging technique in patients with renal/ureteric colic. Many reasons are attributed to this including speed, greater sensitivity for stone detection, diagnosis of additional findings and utility in appropriate patient management<sup>[15]</sup>. Only significant disadvantage of CT is the radiation exposure, particularly in young patients. To decrease radiation dose, various low dose protocols and techniques have been proposed with performance nearly similar to standard-dose CT<sup>[1]</sup>. This involves significant reduction in the tube current or increased pitch, both of which result in lower radiation dose to patient. Low-dose CT has become the standard for diagnosing urolithiasis with various protocols and low dose settings resulting in a different radiation exposure.

Suspecting the diagnosis of renal colic without having any information about the calculus size and location is usually not sufficient to select the most appropriate therapeutic approach, the need for hospitalization, or the need for extracorporeal shockwave lithotripsy or other urologic procedures<sup>[4,16]</sup>. The size and location of the calculus, particularly ureteric calculi, are determinants of the likelihood of spontaneous stone passage and Characterization of stone morphology and location are the major advantages

of CT over other imaging techniques (abdominal radiography, sonography) commonly used in the initial evaluation of patients with suspected renal colic<sup>[4,17]</sup>.

In our study, 88 calculi were detected on standard-dose CT, of which 64 were renal calculi and 24 were ureteric calculi. 22 renal calculi were <5mm in size and of these, only 18 were detected on low-dose CT implying a sensitivity of approx. 82%. No renal calculus >5 mm was missed on low-dose CT, implying that low-dose CT was equally sensitive to standard-dose CT for identifying renal calculi >5mm size. Of 24 ureteric calculi seen on standard-dose CT, 22 were detected accurately on low-dose CT while 2 were missed with sensitivity of approx. 92%. Two phleboliths were overestimated as ureteric calculi on low-dose CT. The missed calculi were <3mm in size and located in lower ureter. It may be stated that calculi <5mm rarely require urologic procedures and 5 mm is generally the critical size for urology referral as chances of spontaneous passage progressively decreases as a calculus exceeds this size<sup>[18-20]</sup>. The results of our comparative study, with those obtained from prior series<sup>[12,21]</sup> suggest that a low-dose CT can be used as the first-line imaging tool in the workup of patients with suspected renal and ureteral colic in non obese patients, providing that clinicians and patients are aware of the limitations and advantages of this technique with regard to standard-dose CT without additional predisposing medical conditions<sup>[22]</sup>.

## Conclusions

Low-dose CT scan is an effective method of identifying and evaluating urinary tract stones. Low-dose CT achieves sensitivities close to those of standard-dose CT for diagnosing renal and ureteral calculi and provides significant dose reduction to patients compared to standard dose CT. Further Low-dose CT may be considered as preferred investigation for the management of urolithiasis, in the scenario of a developing country.

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