

## Original Research Article

# Low dose computed tomography KUB region for management of urolithiasis in Indian scenario

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## ABSTRACT

**Background:** The incidence, prevalence and recurrence of urolithiasis are very high; especially in the north-western part of India. Ultrasonography has decreased sensitivity and specificity as compared with NCCT for detection of both renal and ureteral calculi. Drawbacks of NCCT in terms of radiation exposure, cost and repeatability can be overcome by Low dose NCCT protocols. Low dose NCCT can be an investigation with high diagnostic accuracy, less radiation hazards and financial acceptability. Aim of this study was to evaluate use of Low dose CT-KUB over ultrasound (US) for diagnosis of urolithiasis, in Indian scenario.

**Methods:** This is a prospective study, at Tertiary Care Hospital. Patients with acute flank pain, who underwent both US and Low dose NCCT within an interval of 24 hours, at Tertiary Care Hospital. Helical CT scanner (Phillips 128 slice medical systems) with exposure factors setting of KVP 120 and mAs 70 was used.

**Results:** A total of 136 Patients with mean age of 33.01 years (range 19-62 years, SD 10.93), were examined with 82(60.29%) males and 54(39.7%) females, average BMI was 25.07(range 17.2 to 35.02). Low Dose NCCT has a sensitivity of 95% (CI of 89.43-98.14%) and specificity of 87.50% (95% CI of 61.65-98.45%) in the diagnosis of urolithiasis. Mean effective dose of radiation administered in low dose CT-KUB was 1.8-2.2 mSv.

**Conclusions:** In view of information, reliability, repeatability, radiation exposure and cost acceptability; unenhanced Low dose CT-KUB region should be the preferred investigation for the management of urolithiasis, in the scenario of a developing country.

**Keywords:** Low dose computed tomography, Noncontrast CT, Urolithiasis

## INTRODUCTION

Urolithiasis is common, with the lifetime risk exceeding 12% in men and 6% in women. The prevalence appears to have increased in recent years. In addition, many patients have recurrent stones, with an estimated rate of 30% to 40% within 5 years.<sup>1</sup> The incidence, prevalence and recurrence of urolithiasis are very high; especially in the north-western part of India.<sup>2</sup> Stone disease not only affects the patient, but also the national economy, as the disease is prevalent in the productive age group.<sup>2</sup> Hence, there is need for an investigation with high diagnostic

accuracy, less radiation hazards and financial acceptability in the context of a developing country.

Ultrasonography (US) is an attractive investigation because of the universal availability; it is less expensive, non-invasive with lack of ionizing radiation. There are limitations to Ultrasound; this is due to its image obscuration due to underlying bowel loops and bony structures.<sup>3</sup> Multiple studies have demonstrated decreased sensitivity and specificity of US compared with CT for detection of both renal and ureteral calculi. This is particularly true for small (<5mm) stones.<sup>4</sup> Density of stone is important for planning the treatment modality.

Ultrasound even with X-ray KUB does not yield any information on stone density and composition.

Non-contrast CT is highly sensitive for stone detection. It can be performed rapidly and needs no intravenous iodinated contrast. It can also identify non-urinary tract pathology. Studies have shown a high sensitivity (97%) and high specificity (95%) of CT for stone disease and alternative diagnoses are found in 10% to 24% of patients with acute flank pain.<sup>5</sup> NCCT can detect most stones regardless of size, composition and location. Unenhanced CT is also increasingly being used for treatment planning and post treatment surveillance for stone recurrence.

The international commission on radiological protection recommends a yearly radiation exposure dose limit of 1 mSv for general population. Overall lifetime risk of developing cancer is generally 1 in 200 for every 100 mSv of radiation exposure.<sup>6</sup> Radiation dose and cost for multiple CT examinations are of great concern and not justifiable. This is particularly true in Indian scenario where recurrence rate is too high.

However, with the availability of new generation CT scanners, it is now possible to acquire cross-sectional images at a much lower effective radiation dose. This is generally less than 3 mSv per examination.<sup>7</sup> Several low dose and ultralow dose protocols have been studied. Low dose CT-KUB can be performed in short time, without requiring any bowel preparation, at far lesser cost as compared to conventional NCCT. It provides accurate information regarding the stone size, location, density, direct and indirect signs of obstruction and even diagnosis of non-urolithiasis conditions.

Present study evaluates the use of low dose CT-KUB for management of urolithiasis: In terms of information yield, reliability, repeatability, radiation exposure and financial acceptability in Indian scenario.

Aim of this study was to evaluate use of Low dose CT-KUB over ultrasound (US) KUB in management of urolithiasis, in Indian scenario.

## METHODS

This is a prospective study conducted from June 2015 to June 2017 at a tertiary care teaching hospital in Pune, western part of India.

Patients (Age group of 18-70 years) who presented with flank pain/symptoms and signs suspected of renal/ureteric colic at casualty or urology OPD were enrolled in study. Patients, who underwent both Ultrasound and low dose unenhanced helical CT (LDCT-KUB) scans within a span of 24 hours, were included in the study.

### Exclusion criteria

- Pregnancy/LMP more than 30 days,

- Age younger than 18 years,
- Previous full dose CT scan in past 6 months.

History, examination and medical records of patients for suspected renal/ureteral colic were noted. Before undergoing USG/ LDCT-KUB all patients were examined.

Reference modality for urolithiasis detection is shown in previous studies.<sup>8</sup> Ureteral stone was considered to be definitely present if at least one of the following criteria were fulfilled:

- Surgical retrieval of the stone,
- Depiction of a ureteral stone by imaging studies (unenhanced CT),
- Subsequent radiographs and sonograms showing evidence of calculus migration,
- Calculus excretion followed by relief of pain,
- Macroscopic hematuria.

The ureteral stone was considered to be definitely absent if imaging studies do not reveal any stone and at least one of the following criteria was fulfilled.

- Negative microscopic urinalysis and relief of pain with no treatment
- Depiction of an alternative diagnosis and relief of pain after a specific treatment
- Laboratory-based alternative diagnosis (e.g., urinary tract infection)
- Imaging studies showed no abnormal calcification or urinary tract dilatation.

Ultrasound KUB was done using 3.75MHz surface probe. All ultrasounds were seen and reported after being reviewed by a senior radiologist. Secondary signs of obstruction, like hydronephrosis, hydroureter, perinephric and periureteric fat stranding were also noted apart from direct visualization of stone.

The low dose CT-KUB scans were obtained on a helical CT scanner (Phillips 128 slice medical systems). The voltage setting was 120 kVp and tube current settings at 70 mAs. All scans were obtained from the upper border of T10 vertebral body to the lower border of symphysis pubis using 5mm collimation, without the use of oral or intravenous contrast material. Patients were placed in supine position with full urinary bladder at the time of the LDCT-KUB.

Effective dose (ED) was obtained by the following equation-  $ED = DLP \times f$

DLP- dose length product is the product of weighted CT dose index (CTDI<sub>w</sub>) and the length of imaged object in centimeters. The average scanned length, for low-dose CT, was 40±5cm for men and 35±5 cm for women.

Effective F is the conversion factor; f for pelvic CT is 0.016 mSv/mGy/cm.

## RESULTS

Study included 136 consecutive patients of acute flank pain who underwent both USG and Low dose CT-KUB region. Patients had mean age of 33.01 years (range 19-62 years, SD 10.93), with 82(60.29%) males and

54(39.7%) females, average BMI was 25.07(range 17.2 to 35.02).

Data from present study showed that Ultrasonography has sensitivity of 80%(71.72-86.75%) with 95% confidence interval, and specificity of 62.5% with (35.43-84.80) 95% confidence interval, when secondary signs of obstruction are also taken into account (Table 1).

**Table 1: Comparison of USG and low dose NCCT for urolithiasis.**

Investigation	True positive	False negative	False positive	True negative	Sensitivity	Specificity
USG	96	24	6	10	80%	62.5%
LD-NCCT	114	6	2	14	95%	87.5%

**Table 2: Comparative sensitivity and specificity of various imaging modalities for urolithiasis.**

Modality	Sensitivity	Specificity	Bowel gas shadow	Time	Additional information	Cost	Effective dose
X-ray <sup>21</sup> (KUB)	57%	71%	Yes	Less	Very few	Low	0.5-1 mSv
IVU <sup>22,23</sup>	59.1%	99%	Yes	Less	Adequate	+	1.3-3.5 mSv
USG <sup>24</sup>	80-84%	50-53%	Yes	Less	Few	+	Nil
USG+X-ray	85-87	90	Yes	Fair	Fair	++	0.5-1 mSv
Ultra-low dose <sup>12</sup>	97	95	No	Less	Fair	++	1-2 mSv
Low dose NCCT <sup>5,10</sup>	96.6%	94.9%	No	Less	Adequate	++	0.97-3 mSv
standard NCCT <sup>11</sup>	98	96	No	Slight	Adequate	+++	6.5-10 mSv
Contrast CT <sup>25</sup>	99	100	No	More	Highest	++++	25-35 mSv

**Table 3: Various low dose NCCT protocols used in literature.**

Various Protocols	Current (mA)	Voltage (kVp)	Pitch	Sensitivity	Specificity	Radiation (mSv)
Ultra-low dose <sup>12</sup>	6.9	120	-	97%	95%	0.5-0.7
MDCT, low-dose <sup>13</sup>	50	120	1.5	93	86	1.4-1.97
Low dose MDCT <sup>10</sup>	30	120	1.25	97	96	1.8-2.4
Present study	70	120	1.5	95	87.5	1.8-2.2
MDCT, conventional protocol <sup>11</sup>	200	140	0.75	99	97	6.5-10

Low Dose NCCT has a sensitivity of 95% with (89.43-98.14%) 95% confidence interval and specificity of 87.50% with (61.65-98.45%) 95% confidence interval, in the diagnosis of calculi. Additionally, LDCT could also suggest stone density (mean 762 HU units) and, non-urinary tract abnormalities as cause of flank pain (mesenteric lymphadenitis in 6 and acute colitis in 4).

Effective dose (ED) was obtained by the following equation-  $ED = DLP \times f$

Thus, ED in the low dose CT protocol was calculated as 1.8-2.2 mSv.

Low dose NCCT KUB cost at the institute is nearly half that of conventional dose CT scan, the radiation exposure is one fifth of standard dose CT. Low dose NCCT-KUB

region takes less scanning time as compared to ultrasonography and X-ray KUB combined.

In the institute cost of USG and X-Ray combined is nearly same as that of low dose NCCT-KUB scan. Abdominal ultrasound with X-ray KUB region takes nearly 24 hours for final diagnosis whereas LDNCCT takes only 2 hours to give diagnosis.

## DISCUSSION

Unenhanced conventional NCCT scan is becoming the standard for imaging patients with renal/ureteric colic. Many reasons for this includes its speed, greater sensitivity for stone detection, diagnosis of additional findings, utility in appropriate patient management.<sup>9</sup> However its cost and radiation exposure are limiting factors.

In order to decrease radiation dose, different low dose protocols have been proposed with performance nearly similar to standard dose CT. It has shown better results than USG in evaluating urolithiasis.<sup>8,10-12</sup> Conventional NCCT and Low dose NCCT has been compared in the medical literature.<sup>12-14</sup>

In a study by Alsyouf and colleagues, low dose CT at variable mAs resulted in similar attenuation values (as a surrogate for stone composition) compared with Conventional-dose CT with only a slight increase in variability.<sup>15</sup> A study by Sohn and associates supported this observation, demonstrating no significant difference in measurement of stone size, attenuation, or SSD between low dose and conventional-dose CT with a marked reduction in radiation dose of 73% (from 23 to 6 mSv).<sup>16</sup> The new techniques for differentiation of urinary calculi with differing compositions are described with dual-energy CT can also be performed at a low dose.<sup>13</sup>

Even ultralow dose CT protocol (30 mAs) results are claimed to be better than USG and X-ray KUB combination. But, they are inferior to Low dose NCCT in detection of renal/ureteric stones.<sup>17</sup>

However, there is a possibility that with reducing the radiation, image quality may be compromised. The clarity of radiographic images is inversely proportional to the amount of current used in mill amperes. There is linear correlation between patient size, image quality and need for adequate scanning protocol for larger patients.<sup>18</sup> Several investigators have documented problems with the low dose protocol in obese patients involving deteriorating image quality and the necessity for higher radiation exposure.<sup>19,20</sup> Some studies have even grouped patients on BMI and offered different dose settings for these groups.<sup>21</sup>

Present study shows that sensitivity and specificity of Low dose NCCT scan KUB region is significantly higher than Ultrasound for detection of urolithiasis (p value less than 0.05). Comparative sensitivity and specificity of various imaging modalities for detecting urolithiasis is shown in Table 2. These findings are similar to previous studies in literature.<sup>5</sup>

CT scanner settings for current and voltage in present study are comparable with various low dose protocols as shown in Table 3.

In the present study radiation exposure is 1.8-2.2 mSv, with is more than ultra-low dose protocols and less than conventional NCCT. Comparative literature results are mentioned in Table 3.

Patients in present study had mean BMI of 24.26. In Indian scenario most of the patients are having BMI of less than 30Kg/m<sup>2</sup>. Hence, similar low dose protocol suffices. However, further studies are needed to ascertain the low dose CT protocols for patients with high BMI.

In the institute, low dose CT-KUB is also cost-effective investigation over USG and radiography combined. Author suggest that institutions should develop their own cost packages for Low dose NCCT-KUB region. However, no formal cost analysis was performed in present study.

## CONCLUSION

In view of information yield, reliability, repeatability, radiation exposure and cost acceptability; Low dose Computed tomography of kidney ureter bladder region (LDCT-KUB) is good primary investigation. LDCT-KUB should be the preferred investigation for the management of acute flank pain and urolithiasis, in Indian scenario.

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## REFERENCES

1. Bhatt K, Monga M, Remer EM. Low-Dose Computed Tomography in the Evaluation of Urolithiasis. *J Endourol.* 2015;29(5):504-11.
2. Ansari MS, Gupta NP, Hemal AK, Dogra PN, Seth A, Aron M, et al. Spectrum of stone composition: Structural analysis of 1050 upper urinary tract calculi from northern India. *Int J Urol.* 2005;12(1):12-6.
3. Ather MH, Jafri AH, Sulaiman MN. Diagnostic accuracy of ultrasonography compared to unenhanced CT for stone and obstruction in patients with renal failure. *BMC Med Imaging.* 2004;4(1):2.
4. Riddell J, Case A, Wopat R, Beckham S, Lucas M, McClung CD, et al. Sensitivity of Emergency Bedside Ultrasound to Detect Hydronephrosis in Patients with Computed Tomography-proven Stones. *West J Emerg Med.* 2014;15(1):96-100.
5. Niemann T, Kollmann T, Bongartz G. Diagnostic performance of low-dose CT for the detection of urolithiasis: A meta-analysis. *Am J Roentgenol.* 2008;191(2):396-401.
6. ICRP. Radiological protection and safety in medicine. ICRP Publication 73. *Ann ICRP.* 1996;26(2).
7. Drake T, Jain N, Bryant T, Wilson I, Somani BK. Should low-dose computed tomography kidneys, ureter and bladder be the new investigation of choice in suspected renal colic?: A systematic review. *Indian J Urol.* 2014;30(2):137-43.
8. Tack D, Sourtzis S, Delpierre I, de Maertelaer V, Gevenois PA. Low-Dose Unenhanced Multidetector CT of Patients with Suspected Renal Colic. *Am J Roentgenol.* 2003;180(2):305-11.
9. Sezer F, Atalar MH, Sezer F. Place of non-contrast computed tomography for evaluation of flank pain

- and suspected urinary stone in emergency service. 2014;42-50.
10. Poletti PA, Platon A, Rutschmann OT, Schmidlin FR, Iselin CE, Becker CD. Low-dose versus standard-dose CT protocol in patients with clinically suspected renal colic. *Am J Roentgenol*. 2007;188(4):927-33.
  11. Katz SI, Saluja S, Brink JA, Forman HP. Radiation dose associated with unenhanced CT for suspected renal colic: Impact of repetitive studies. *Am J Roentgenol*. 2006;186(4):1120-4.
  12. Kluner C, Hein PA, Gralla O, Hein E, Hamm B, Romano V, et al. Does ultra-low-dose CT with a radiation dose equivalent to that of KUB suffice to detect renal and ureteral calculi? *J Comput Assist Tomogr*. 2006;30(1):44-50.
  13. Kim BS, Hwang IK, Choi YW, Namkung S, Kim HC, Hwang WC, et al. Low-dose and standard-dose unenhanced helical computed tomography for the assessment of acute renal colic: prospective comparative study. *Acta radiol*. 2005;46:756-63.
  14. Abou El-Ghar ME, Shokeir AA, Refaie HF, El-Nahas AR. Low-dose unenhanced computed tomography for diagnosing stone disease in obese patients. *Arab J Urol*. 2012;10(3):279-83.
  15. Alsyouf M, Smith DL, Olgin G, Heldt JP, Lightfoot M, Li R, et al. Comparing stone attenuation in low- and conventional-dose noncontrast computed tomography. *J Endourol*. 2014;28(6):704-7.
  16. Sohn W, Clayman RV, Lee JY, Cohen A, Mucksavage P. Low-dose and standard computed tomography scans yield equivalent stone measurements. *Urol*. 2013;81(2):231-4.
  17. Jin DH, Lamberton GR, Broome DR, Saaty HP, Bhattacharya S, Lindler TU, et al. Effect of reduced radiation CT protocols on the detection of renal calculi. *J Urol*. 2010;184(4):1379-80.
  18. Kalra MK, Maher MM, Toth TL, Schmidt B, Westerman BL, Morgan HT, et al. Techniques and Applications of Automatic Tube Current Modulation for CT. *Radiology*. 2004;233(3):649-57.
  19. Malkawi IM, Han E, Atalla CS, Santucci RA, O'Neil B, Wynberg JB. Low-Dose (10%) Computed Tomography May Be Inferior to Standard-Dose CT in the Evaluation of Acute Renal Colic in the Emergency Room Setting. *J Endourol*. 2016;30(5):493-6.
  20. McLaughlin PD, Murphy KP, Hayes SA, Carey K, Sammon J, Crush L, et al. Non-contrast CT at comparable dose to an abdominal radiograph in patients with acute renal colic; impact of iterative reconstruction on image quality and diagnostic performance. *Insights Imaging*. 2014;5(2):217-30.
  21. Turk C, Petrik A, Sarica K, Seitz C, Skolarikos A, Straub M, et al. EAU Guidelines on Urolithiasis. *Eur Assoc Urol*. 2015;69(3):475-82.
  22. Wang JH, Shen SH, Huang SS, Chang CY. Prospective comparison of unenhanced spiral computed tomography and intravenous urography in the evaluation of acute renal colic. *J Chinese Med Assoc*. 2008;71(1):30-6.
  23. Thomson JM, Glocer J, Abbott C, Maling TM. Computed tomography versus intravenous urography in diagnosis of acute flank pain from urolithiasis: A randomized study comparing imaging costs and radiation dose. *Australas Radiol*. 2001;45(3):291-7.
  24. Smith-Bindman R, Aubin C, Bailitz J, Bengiamin RN, Camargo CA, Corbo J, et al. Ultrasonography versus Computed Tomography for Suspected Nephrolithiasis. *N Engl J Med*. 2014;371(12):1100-10.
  25. Van-Der-Molen AJ, Cowan NC, Mueller-Lisse UG, Nolte-Ernsting CCA, Takahashi S, Cohan RH, et al. CT urography: definition, indications and techniques. A guideline for clinical practice. *Eur Radiol*. 2008;18(1):4-17.

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