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RESEARCH ARTICLE

Diagnostic Accuracy of Low-Dose CT versus Standard-Dose CT in the Detection of Urolithiasis

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ABSTRACT

Non-contrast CT is the reference imaging test for urolithiasis, but the associated radiation dose is a concern, especially in young patients who may undergo repeated scans. This study assessed the diagnostic accuracy of low-dose CT (LDCT) against standard-dose CT (SDCT) for the detection of urinary tract stones. In this prospective comparative study at Al-Hussein Teaching Hospital in Al-Nasiriyah (Thi-Qar Province, Iraq), 150 adults with suspected renal colic underwent both LDCT and SDCT in the same session. SDCT served as the reference standard. Two radiologists, blinded to the reference reading, independently interpreted the LDCT images. Per-patient and per-stone sensitivity, specificity, predictive values, and accuracy were calculated with 95% confidence intervals (CI), with subgroup analysis by stone size and body mass index (BMI) and comparison of effective radiation dose. Reporting followed the STARD 2015 guideline. Urolithiasis was present in 102 of 150 patients (68%). LDCT achieved a per-patient sensitivity of 95.1% (95% CI 88.9–98.4), specificity of 97.9% (95% CI 89.1–99.9), and accuracy of 96.0%. Per-stone sensitivity was 94.0% overall but fell sharply for stones smaller than 3 mm (69.2% vs 98.6% for ≥ 3 mm; $p < 0.001$) and was lower in patients with BMI ≥ 30 (88.9% vs 97.2%). Inter-observer agreement was excellent ($\kappa = 0.88$). The mean effective dose was 76% lower with LDCT (1.9 ± 0.5 vs 8.1 ± 1.8 mSv; $p < 0.001$). LDCT detected urolithiasis with high accuracy at roughly one-quarter of the radiation dose of SDCT and can serve as the first-line protocol for suspected renal colic. Its main limitation is reduced sensitivity for sub-3-mm stones and in obese patients, where a standard-dose protocol should be considered.

KEYWORDS

Computed tomography; low-dose CT; urolithiasis; renal colic; diagnostic accuracy; radiation dose.

ARTICLE INFORMATION

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1. Introduction

Since the demonstration in the mid-1990s that non-contrast helical CT outperforms intravenous urography for acute flank pain, unenhanced CT has become the reference imaging test for suspected urolithiasis, offering high sensitivity and specificity and the ability to reveal alternative diagnoses.[1,2,3] Current appropriateness guidance endorses non-contrast CT as the primary imaging study for acute flank pain when a stone is suspected.[4].

The principal drawback of CT is ionising radiation. Patients with stone disease are frequently young and prone to recurrence, so they may undergo repeated scans over a lifetime, and the cumulative dose is a recognised concern.[5] This concern is amplified by the rising use of CT for suspected urolithiasis in emergency settings,[6] and current European guidance similarly emphasises limiting radiation while preserving diagnostic yield.[7] These considerations motivate dose reduction consistent with the ALARA (as low as reasonably achievable) principle, provided diagnostic performance is preserved.

Low-dose CT (LDCT) protocols — typically delivering an effective dose below 3 mSv through reduced tube current, lower tube voltage, and iterative reconstruction — have been reported to maintain high accuracy for stone detection. A seminal comparative study and subsequent meta-analyses reported pooled sensitivities around 93–97% and specificities around 95–97% for LDCT relative to standard-dose or reference imaging.[8,9,10] Modern iterative reconstruction algorithms are central to this achievement, substantially reducing image noise at low dose and preserving stone detection compared with filtered back-projection.[11,12] Successive dose reductions have been explored down to sub-millisievert, ultra-low-dose levels.[13,14] However, performance varies with stone size and patient body habitus,[15] and rigorous, transparently reported local data remain valuable, particularly from regions such as Thi-Qar Province in southern Iraq where urinary stone disease is highly prevalent. The aim of this study was to determine the diagnostic accuracy of LDCT against SDCT as the reference standard for the detection of urolithiasis in a Thi-Qar cohort, and to examine the influence of stone size and BMI while quantifying the achievable dose reduction.

2. Materials and Methods

2.1 Study design and setting

This prospective comparative diagnostic accuracy study was conducted in the Department of Radiology at Al-Hussein Teaching Hospital, Al-Nasiriyah, Thi-Qar Province, Iraq, over a 12-month period. The study was approved by the institutional research ethics committee, and all participants provided written informed consent, including consent for the incremental radiation of a second acquisition. Reporting adheres to the STARD 2015 statement for diagnostic accuracy studies.[16,17,18].

2.2 Participants

Consecutive adults (≥ 18 years) presenting to the emergency and urology departments of Al-Hussein Teaching Hospital in Al-Nasiriyah with acute flank pain and clinically suspected renal colic were recruited. Exclusion criteria were pregnancy, known non-calculous cause of pain, haemodynamic instability, and inability to consent. Each participant underwent LDCT immediately followed by SDCT of the kidneys, ureters, and bladder in the same session, without repositioning. A total of 150 patients were enrolled. The recruitment of a local Thi-Qar cohort was intended to provide region-specific evidence, given the high regional burden of urinary stone disease.

2.3 Imaging, reference standard, and interpretation

Both acquisitions were performed on the same multidetector scanner. SDCT used the department's standard renal-colic protocol and served as the reference standard; LDCT used reduced tube current and low tube voltage with iterative reconstruction, an approach shown to permit substantial dose reduction while maintaining image quality.[11] Two radiologists, blinded to clinical details and to the reference reading, independently interpreted the LDCT images for the presence, number, size, and location of calculi; disagreements were resolved by consensus. The reference SDCT reading was performed separately by a third radiologist. Stone size was recorded as the maximum axial diameter, and patients were grouped by BMI (< 30 versus ≥ 30 kg/m^2). The effective dose was estimated from the dose–length product using published conversion factors.[19].

2.4 Statistical analysis

Sensitivity, specificity, positive and negative predictive values (PPV, NPV), and accuracy were calculated at the per-patient and per-stone levels, each with 95% CIs (Wilson method). Paired proportions were compared with the McNemar test, and subgroup sensitivities (stone size, BMI) with the chi-square or Fisher exact test. Inter-observer agreement for LDCT was assessed with the Cohen κ statistic. Effective doses were compared with the paired-samples t-test. A two-sided p-value < 0.05 was considered statistically significant.

3. Results

3.1 Participants and stone burden

Of 150 patients (mean age 43.6 ± 12.8 years; 61.3% male), urolithiasis was confirmed on SDCT in 102 (68.0%). A total of 168 calculi were identified on the reference standard, of which 142 (84.5%) measured ≥ 3 mm and 26 (15.5%) measured < 3 mm. Baseline characteristics are summarised in **Table 1**.

Table 1. Participant characteristics and stone burden (n = 150).

Characteristic	Value
Age, years — mean ± SD	43.6 ± 12.8
Male sex — n (%)	92 (61.3)
BMI, kg/m² — mean ± SD	27.9 ± 4.7
BMI ≥ 30 — n (%)	45 (30.0)
Patients with urolithiasis on SDCT — n (%)	102 (68.0)
Total calculi on SDCT — n	168
Calculi ≥ 3 mm — n (%)	142 (84.5)
Calculi < 3 mm — n (%)	26 15.5)

3.2 Diagnostic accuracy of LDCT

Against SDCT as the reference standard, LDCT correctly classified 97 of 102 patients with stones and 47 of 48 without, giving a per-patient sensitivity of 95.1% (95% CI 88.9–98.4), specificity of 97.9% (95% CI 89.1–99.9), PPV of 99.0%, NPV of 90.4%, and overall accuracy of 96.0% (**Figure 1**; **Table 2**). Inter-observer agreement for LDCT interpretation was excellent (κ = 0.88). Per-stone sensitivity was 94.0% (158/168).

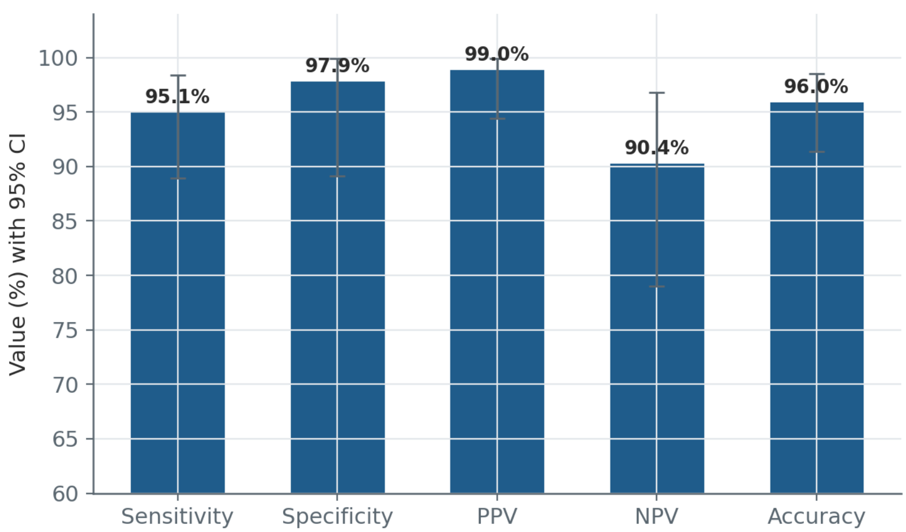

Figure 1. *Per-patient diagnostic performance of LDCT against SDCT as the reference standard (bars = point estimate; whiskers = 95% CI).*

Table 2. Diagnostic performance of LDCT versus SDCT (reference standard).

Measure	Per-patient (95% CI)	Per-stone (95% CI)
Sensitivity	95.1% (88.9–98.4)	94.0% (89.4–96.9)
Specificity	97.9% (89.1–99.9)	—
PPV	99.0% (94.4–99.9)	—
NPV	90.4% (79.0–96.8)	—
Accuracy	96.0% (91.4–98.5)	—

3.3 Effect of stone size and body habitus

Per-stone sensitivity depended strongly on calculus size: LDCT detected 140 of 142 stones ≥ 3 mm (98.6%) but only 18 of 26 stones < 3 mm (69.2%; $p < 0.001$). Sensitivity was also lower in patients with BMI ≥ 30 than in non-obese patients (88.9% vs 97.2%) (**Figure 2**). All eight missed stones were sub-3-mm calculi, five of which occurred in patients with BMI ≥ 30.

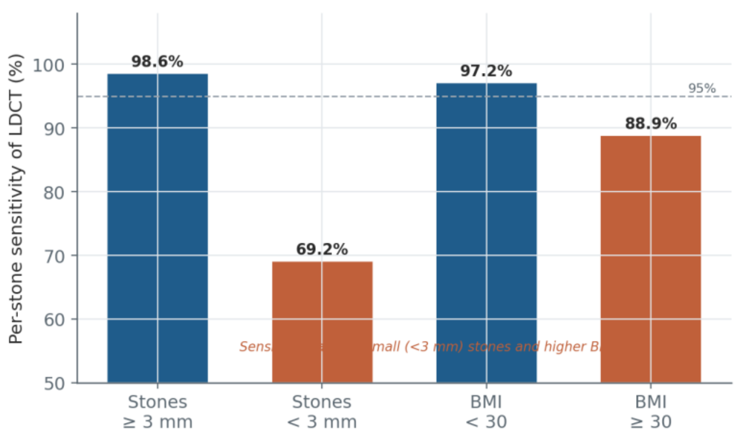

Figure 2. *Per-stone sensitivity of LDCT by stone size and BMI subgroup; sensitivity falls for sub-3-mm stones and higher BMI.*

3.4 Radiation dose

The mean effective dose was substantially lower with LDCT than SDCT (1.9 ± 0.5 vs 8.1 ± 1.8 mSv), a 76% reduction ($p < 0.001$) (**Figure 3**; **Table 3**).

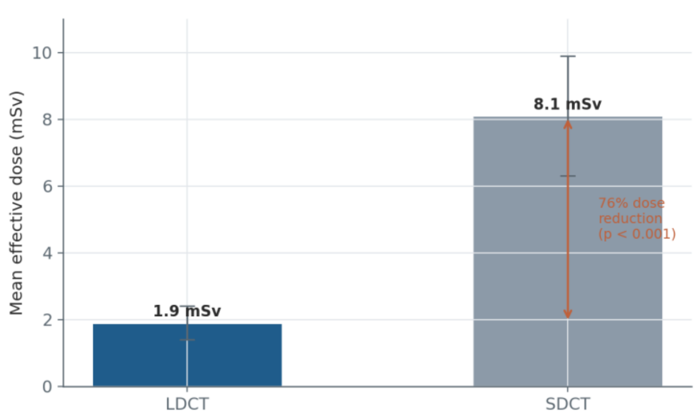

Figure 3. *Mean effective radiation dose for LDCT versus SDCT (error bars = SD).*

Table 3. Subgroup sensitivity and radiation dose.

Parameter	LDCT	SDCT / comparator
Sensitivity, stones ≥ 3 mm	98.6%	reference
Sensitivity, stones < 3 mm	69.2%	reference
Sensitivity, BMI < 30	97.2%	reference
Sensitivity, BMI ≥ 30	88.9%	reference
Effective dose, mSv — mean ± SD	1.9 ± 0.5	8.1 ± 1.8

4. Discussion

In this prospective comparison, LDCT detected urolithiasis with high per-patient sensitivity and specificity and excellent inter-observer agreement, while delivering roughly one-quarter of the effective dose of SDCT. These results are consistent with a seminal comparative study and with pooled meta-analytic estimates, supporting LDCT as a first-line protocol for suspected renal colic.[8,9,10].

The clinically important limitation was reduced sensitivity for stones smaller than 3 mm and, to a lesser extent, in obese patients — the expected consequence of increased image noise at low dose, which most affects the smallest, lowest-contrast targets and patients with greater soft-tissue attenuation. Reassuringly, sub-3-mm stones are frequently of limited clinical consequence and often pass spontaneously, so the impact of missing them on management is usually small; nonetheless, when a small distal stone would change management, or in larger patients, a standard-dose acquisition remains justified.[7,15].

The dose reduction achieved here is clinically meaningful given that stone-forming patients are typically young and subject to recurrent imaging over decades, so lowering the per-examination dose reduces cumulative exposure and its associated stochastic risk, in line with the ALARA principle and appropriateness guidance.[4,5,20] Wider adoption of LDCT could therefore mitigate the radiation burden associated with the rising use of CT for urolithiasis.[6] A further strength of non-contrast CT that is largely preserved at low dose is the detection of clinically relevant alternative diagnoses for flank pain, first highlighted in the early comparative literature.[3].

4.1 Limitations

This study has limitations. Using SDCT rather than stone retrieval or composition analysis as the reference standard may overestimate agreement, since both acquisitions share the same modality and any modality-specific blind spots. Performing two acquisitions raises an ethical consideration regarding incremental dose, mitigated here by consent and by the low dose of the index test. The single-centre design and the exclusion of pregnant patients limit generalisability, and inter-scanner variation was not assessed. Adherence to the STARD checklist strengthens transparency but cannot remove these design constraints.[16].

5. Conclusion

Low-dose CT detected urolithiasis with high diagnostic accuracy — per-patient sensitivity 95.1% and specificity 97.9% — at approximately one-quarter of the radiation dose of standard-dose CT. Its principal weakness is reduced sensitivity for sub-3-mm stones and in obese patients. LDCT is recommended as the default protocol for suspected renal colic, reserving standard-dose CT for larger patients or when detecting a small stone would alter management. Multicentre studies with a composition-based reference standard would further strengthen the evidence.

Declarations

Ethics approval. Granted by the institutional research ethics committee; written informed consent was obtained from all participants.

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Conflicts of interest. The authors declare no conflicts of interest.

References

1. Smith RC, Rosenfield AT, Choe KA, et al. Acute flank pain: comparison of non-contrast-enhanced CT and intravenous urography. Radiology. 1995;194(3):789–794. doi:10.1148/radiology.194.3.7862980
2. Sommer FG, Jeffrey RB, Rubin GD, et al. Detection of ureteral calculi in patients with suspected renal colic: value of reformatted noncontrast helical CT. AJR Am J Roentgenol. 1995;165(3):509–513. doi:10.2214/ajr.165.3.7645461
3. Smith RC, Verga M, McCarthy S, Rosenfield AT. Diagnosis of acute flank pain: value of unenhanced helical CT. AJR Am J Roentgenol. 1996;166(1):97–101. doi:10.2214/ajr.166.1.8571915
4. Coursey CA, Casalino DD, Remer EM, et al. ACR Appropriateness Criteria acute onset flank pain—suspicion of stone disease. Ultrasound Q. 2012;28(3):227–233. doi:10.1097/RUQ.0b013e3182625974
5. Katz SI, Saluja S, Brink JA, Forman HP. Radiation dose associated with unenhanced CT for suspected renal colic: impact of repetitive studies. AJR Am J Roentgenol. 2006;186(4):1120–1124. doi:10.2214/AJR.04.1838
6. Balthazar P, Sadigh G, Hughes D, et al. Increasing use, geographic variation, and disparities in emergency department CT for suspected urolithiasis. J Am Coll Radiol. 2019;16(11):1547–1553. doi:10.1016/j.jacr.2019.05.033
7. Türk C, Petřík A, Sarica K, et al. EAU guidelines on diagnosis and conservative management of urolithiasis. Eur Urol. 2016;69(3):468–474. doi:10.1016/j.eururo.2015.07.040
8. 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. AJR Am J Roentgenol. 2007;188(4):927–933. doi:10.2214/AJR.06.0793
9. Niemann T, Kollmann T, Bongartz G. Diagnostic performance of low-dose CT for the detection of urolithiasis: a meta-analysis. AJR Am J Roentgenol. 2008;191(2):396–401. doi:10.2214/AJR.07.3414
10. Xiang H, Chan M, Brown V, Huo YR, Chan L, Ridley L. Systematic review and meta-analysis of the diagnostic accuracy of low-dose CT of the kidneys, ureters and bladder for urolithiasis. J Med Imaging Radiat Oncol. 2017;61(5):582–590. doi:10.1111/1754-9485.12587
11. Kulkarni NM, Uppot RN, Eisner BH, Sahani DV. Radiation dose reduction at multidetector CT with adaptive statistical iterative reconstruction for evaluation of urolithiasis: how low can we go? Radiology. 2012;265(1):158–166. doi:10.1148/radiol.12112470
12. McLaughlin PD, Murphy KP, Hayes SA, 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):217–230. doi:10.1007/s13244-014-0310-z
13. Rob S, Bryant T, Wilson I, Somani BK. Ultra-low-dose, low-dose, and standard-dose CT of the kidney, ureters, and bladder: is there a difference? Results from a systematic review of the literature. Clin Radiol. 2017;72(1):11–15. doi:10.1016/j.crad.2016.10.005
14. Hur J, Park SB, Lee JB, et al. CT for evaluation of urolithiasis: image quality of ultralow-dose (sub-mSv) CT with knowledge-based iterative reconstruction and diagnostic performance of low-dose CT with statistical iterative reconstruction. Abdom Imaging. 2015;40(8):2432–2440. doi:10.1007/s00261-015-0411-2
15. Gervaise A, Naulet P, Beuret F, et al. Low-dose CT with automatic tube current modulation, adaptive statistical iterative reconstruction, and low tube voltage for the diagnosis of renal colic: impact of body mass index. AJR Am J Roentgenol. 2014;202(3):553–560. doi:10.2214/AJR.13.11350
16. Bossuyt PM, Reitsma JB, Bruns DE, et al. STARD 2015: an updated list of essential items for reporting diagnostic accuracy studies. BMJ. 2015;351:h5527. doi:10.1136/bmj.h5527
17. Cohen JF, Korevaar DA, Altman DG, et al. STARD 2015 guidelines for reporting diagnostic accuracy studies: explanation and elaboration. BMJ Open. 2016;6(11):e012799. doi:10.1136/bmjopen-2016-012799
18. Korevaar DA, Cohen JF, Reitsma JB, et al. Updating standards for reporting diagnostic accuracy: the development of STARD 2015. Res Integr Peer Rev. 2016;1:7. doi:10.1186/s41073-016-0014-7
19. Mettler FA Jr, Huda W, Yoshizumi TT, Mahesh M. Effective doses in radiology and diagnostic nuclear medicine: a catalog. Radiology. 2008;248(1):254–263. doi:10.1148/radiol.2481071451
20. Neisius A, Wang AJ, Wang C, et al. Radiation exposure in urology: a genitourinary catalogue for diagnostic imaging. J Urol. 2013;190(6):2117–2123. doi:10.1016/j.juro.2013.06.013