

Review Areas in CT KUB: Think SALT N' SUGAR

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Abstract

Background: Computed tomography of the kidneys, ureters, and bladder (CT KUB) is widely used for evaluating suspected renal or ureteric colic. However, it may also reveal clinically significant findings beyond urinary tract calculi.

Objective: To determine the diagnostic yield of CT KUB in detecting renal and ureteric calculi, assess additional non-urinary tract findings, and propose a memory aid for systematic review of CT KUB.

Methodology: Following approval from the Institutional Review Board, 139 CT KUB examinations requested for suspected renal/ureteric colic were retrospectively reviewed by two consultant radiologists with extensive experience in emergency radiology. Each scan was evaluated for urinary tract calculi, their location, and presence or absence of obstruction. Additional extra-urinary findings were also recorded.

Results: Of the 139 CT KUB examinations, 77 (55.4%) demonstrated urinary tract calculi, while 62 (44.6%) did not. Among the 77 positive cases, 36 (46.8%) were non-obstructive and 41 (53.2%) were obstructive. Calculi were localized to the kidney in 35 cases (46%), ureter in 24 (31%), and both kidney and ureter in 18 (23%). Extra-urinary findings were detected in 37 patients (26.6%), of which 24 (17.3%) were clinically significant (e.g., appendicitis, intussusception, urogenital infections, osseous fracture, ovarian mass) and 13 (9.4%) were incidental or non-acute.

Conclusion: Approximately one-fourth of CT KUB examinations revealed clinically relevant extra-urinary findings, underscoring the importance of a systematic review approach. The mnemonic “SALT n’ SUGAR” *Stranding (fat), Appendix, Lung bases, Terminal ileum, Nodes (lymph), Skeleton, Urogenital (non-calculus), Gallbladder, Adnexae, Rest of colon*, serves as a practical aid to ensure comprehensive interpretation.

Keywords: Renal calculi; Ureteric colic; CT KUB; Extra-urinary findings.

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Introduction

Urinary tract calculi are a prevalent global health challenge with an increasing incidence, contributing to significant clinical and economic burdens worldwide [1]. Renal or ureteric colic is a common cause of emergency room (ER) visits, accounting for approximately one million presentations annually in the United States alone [2]. The incidence of urinary tract calculi varies geographically [3], with recent studies demonstrating a strong association between higher ambient temperatures and increased stone



formation [4]. Dehydration is a well-established risk factor [5], and hematocrit levels, as an indirect marker of hydration status, have also been implicated in stone pathogenesis [6].

Computed tomography of the kidneys, ureters, and bladder (CT KUB) is considered the gold-standard imaging modality for suspected ureteric colic in adults (excluding pregnant women) due to its high sensitivity and specificity for detecting urinary tract calculi [7,8]. According to Royal College of Radiologists (RCR) audit standards, CT KUB should demonstrate calculi in approximately 44–64% of patients [9]. Although it is not recommended as a screening tool for non-specific abdominal pain, CT KUB can establish or suggest alternative diagnoses in an additional 6–18% of cases [9], with some studies reporting rates as high as 45% [10]. Common alternative pathologies identified include non-calculous genitourinary, gastrointestinal, and gynecological conditions [11].

Because CT KUB is performed without intravenous contrast, evaluation of extra-urinary pathology can be challenging. Therefore, a systematic review approach is essential to avoid missing clinically significant findings. The present study aims to assess the diagnostic yield of CT KUB not only for urinary tract calculi but also for alternative diagnoses. We further propose a simple mnemonic “SALT n’ SUGAR” to guide radiologists in reviewing key anatomical regions and identifying non-calculous causes of abdominal pain on unenhanced, low-dose CT studies.

Methodology

Study Design and Setting:

This was a retrospective observational study conducted at Salisbury District Hospital, Salisbury NHS Foundation Trust.

Study Duration:

The study covered a two-month period from September to October 2023.

Study Population:

A total of 139 consecutive CT KUB examinations performed with the clinical indication of suspected renal or ureteric colic were included.

Inclusion Criteria:

- Adult patients (≥ 18 years) undergoing CT KUB for suspected renal/ureteric colic.
- Scans performed within the study period.

Exclusion Criteria:

- Pregnant patients.
- CT scans performed for indications other than renal/ureteric colic.
- Incomplete or poor-quality imaging studies.

Imaging Review:

All scans were independently reviewed by two consultant radiologists with extensive experience in emergency radiology. Each scan was evaluated for:

- Presence or absence of urinary tract calculi.
- Exact anatomical location of calculi.
- Presence or absence of obstruction.

Extra-Urinary Findings:

Any additional findings outside the urinary tract were recorded and categorized as:

- Clinically significant/acute (e.g., appendicitis, intussusception, urogenital infections, fractures).
- Incidental/non-acute findings.



Data Collection and Management:

Relevant findings were documented in a structured proforma and entered into a secure database for analysis.

Statistical Analysis:

Data were analyzed using IBM SPSS Statistics version 22. Descriptive statistics were applied: categorical variables were summarized as frequencies and percentages, while continuous variables were expressed as means $\pm$ standard deviation (SD) where applicable. Inter-observer agreement between the two radiologists was assessed using Cohen's Kappa (κ) statistic.

Results:

A total of 137 patients underwent CT KUB during the study period, with two patients

scanned twice, resulting in 139 CT KUB examinations. Of these, 73 were male and 64 were female, with an age range of 20–81 years (mean $\pm$ SD: 50.5 $\pm$ 17.6 years).

Out of 139 CT KUB examinations, 77 (55.4%) demonstrated urinary tract calculi, while 62 (44.6%) did not. Among the 77 positive cases, 36 (46.8%) were non-obstructive and 41 (53.2%) were obstructive. In terms of distribution, calculi were confined to the kidney in 35 cases (46%), localized to the ureter in 24 cases (31%), and present in both kidney and ureter in 18 cases (23%).

Extra-urinary findings were identified in 37 cases (26.6%), of which 24 (17.3%) represented clinically significant acute pathologies and 13 (9.4%) were incidental or non-acute. The distribution of acute alternative diagnoses is summarized in **Table 1**.

Table 1. Acute alternative diagnoses on CT KUB (n=24)

Diagnosis	Cases (n)
Acute pyelonephritis	6
Sigmoid diverticulitis	4
Acute cholecystitis	2
Cystitis/prostatitis	2
Adnexal cyst	2
Sigmoid colitis/epiploic appendagitis	1
Worsening vertebral fracture	1
Hemorrhagic renal cyst	1
Urinary retention	1
Intussuscepting colonic tumor	1
Femoral artery inflammation	1
Basal consolidation	1
Pneumothorax	1

Representative examples of acute extra-urinary pathologies are shown in **Figure 1** and **Figure 2**.

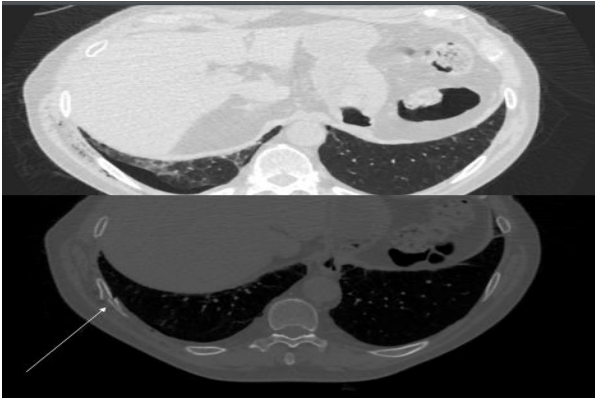


Figure 1: Right rib fracture with associated pneumothorax detected on CT KUB in a 78-year-old male presenting with right flank pain.

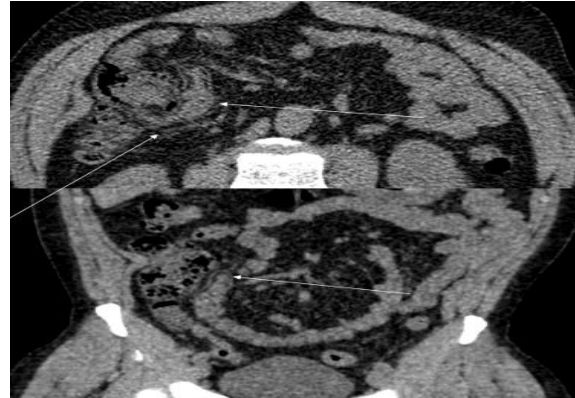


Figure 2: Terminal ileitis with perienteric fat stranding on CT KUB in a 47-year-old male presenting with right loin pain and microscopic hematuria.

Incidental non-acute findings on CT KUB, although not directly related to the patient's presenting complaint, are clinically relevant as

they may uncover unsuspected conditions requiring follow-up or further evaluation. In our study, 13 patients (9.4%) demonstrated incidental pathologies, summarized in **Table 2**.

Table 2. Incidental non-acute diagnoses on CT KUB (n=13)

Diagnosis	Cases (n)
Lymphoma	6
Fatty liver	4
Splenic nodule	2
Hemorrhagic renal cyst	2
Pars interarticularis defects	2
Postmenopausal uterine hyperdensity	1
Vertebral pedicle hemangioma	1
Hepatic subcapsular calcification	1
Renal nodule	1
Spondylodiscitis	1
Ureterocele	1
Old T12 compression fracture	1
Widespread lymphadenopathy	1

There was 100% concordance between the two radiologists in identifying both urinary and extra-

urinary findings, with a Cohen's Kappa (κ) = 1.00, indicating perfect inter-observer agreement.

DISCUSSION:

Acute renal/ureteric colic is one of the most frequent ER presentations and acute or chronic flank pain is the major complaint in a substantial number of patients presenting to the ER [12]. Previous studies have reported incidental findings in up to 10–15% of CT KUB examinations, including lymphadenopathy, hepatic lesions, and musculoskeletal abnormalities [12]. In our study, 13 patients (9.4%) demonstrated such incidental pathologies

The patients presenting with urinary tract pain are usually aged 30-60 years [13]. Urinary tract stone disease typically recurs and greater than 50% of the affected individuals suffer from multiple episodes of pain [14].

The precise diagnosis of urinary tract stone disease requires an in-depth clinical history and examination, excluding all other causes of pain, in addition to laboratory findings [13]. CT KUB without contrast is now the gold standard imaging investigation for evaluation urinary tract calculi [15]. It has a remarkable sensitivity and specificity in this regard, both ranging 96–100% [13]. Initial KUB radiographs have now been deemed unnecessary for the diagnosis. CT KUB also has clear advantages over intravenous urography (IVU) including elimination of risks associated with IV contrast administration. However, increased radiation dose is a concern (4.7-6.5 mSv compared to 1.5-3.5 mSv in an IVU examination). This has been mitigated using low dose protocols in many centers [16]. A vital factor to consider here is the additional capability of CT KUB to suggest alternate diagnoses for urinary tract pain [17].

In our study, the proportion of cases that revealed an alternate diagnosis was 17.3%. This is comparable to similar other articles that have elaborated a range of 10-15%. The alternate acute

diagnoses in these studies revealed a similar constellation of findings involving adnexa, bowel, appendix, liver, gallbladder and skeletal system [13]. One reason for the difference in quoted figures regarding acute alternate diagnoses across these past studies is the definition of incidental and clinically significant findings. Another reason can be the degree of suspicion of an underlying urinary tract calculus by the physician and also how often an alternate etiology was borne in mind. Nadeem et al. concluded that urinary tract stone diagnosis rate was remarkably higher among urologists (67%) and ER specialists (67%), with a relatively lower rate in the other specialists (43%). On the other hand, urologists considered an alternative etiology quite less frequently (12%) than the ER physicians (18%) and other specialty doctors (24%) [18].

According to our results, 9.4% of the patients had non-emergent incidental findings which is comparable to the research by Salam et al. which quoted a figure of 10% for such cases [19]. The spectrum of the acute and non-acute alternative diagnoses in their study was also similar to ours, predominantly related to hepatobiliary, gastrointestinal and genitourinary systems.

We were able to pinpoint a number of review areas regarding evaluation of a CT KUB. One of our patients presenting with right renal colic actually had right 10th rib fracture with a small pneumothorax and another patient with similar symptoms had a right lower lobe pneumonia. This highlights the importance of carefully reviewing the ‘corners of the study’ or in other words the most cranial and the most caudal images.

We also emphasized fat stranding as a vital feature to search for since in our patients with pyelonephritis, sigmoid colitis, acute appendicitis, terminal ileitis, diverticulitis, epididymo-orchitis, cholecystitis, and colonic



tumor this was a major finding. This feature was particularly helpful in absence of IV contrast. Previous literature has also underscored the benefit of seeking for this sign in patients with acute abdomen [20].

The acronym SALT n' SUGAR will be helpful to remember the non-calculus causes of abdominal pain mimicking renal/ureteric colic. It stands for stranding (fat), appendix, lung bases, terminal ileum, nodes (lymph), skeleton, urogenital (non-calculus), gallbladder, adnexae, and rest of colon.

LIMITATIONS:

The major limitation of our study was that we did not assess the follow up of the patients with acute alternate diagnoses regarding the management as to which ones were managed conservatively and which ones required intervention. This can further give a deeper insight into the treatment costs involved when an alternate diagnosis is made, thus further emphasizing their importance.

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CONCLUSION:

About one-fourth of the CT KUB examinations can show important additional findings outside the urinary tract. The acronym SALT n' SUGAR will be helpful to remember the non-calculus causes of abdominal pain mimicking renal/ureteric colic particularly for radiology residents and registrars working in acute settings. It is important to carefully assess the CT KUB review areas so that findings of paramount clinical significance are not missed.

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Conflict of Interest

All authors affirm that there are no financial or non-financial conflicts of interest that could have influenced the conduct or reporting of this study.



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