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Rationale use of unenhanced multi-detector CT (CT KUB) in evaluation of suspected renal colic

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ABSTRACT

Objective: To assess the yield of non-contrast enhanced CT (CT KUB) across different ordering specialties and need of developing an algorithm for its rationale use.
Materials and methods: We retrospectively reviewed 1550 consecutive CT KUB studies requested for suspected renal colic carried out at a single institution in a calendar year. The data was analyzed for demographic characteristics, referring clinician and final diagnosis. Only patients with CT as primary imaging for clinically suspected reno-ureteral colic were included. Departments ordering these CT KUB examinations were divided into three divisions: Urologist, emergency room (ER) physician and others.
Results: Of 1550 CT KUB performed in the study period 766 met the inclusion criteria. Urologists (57%), followed by ER physicians (30%) mostly ordered the examination. The overall positive yield for urolithiasis was 64% ($n = 490$), rate of incidental/alternate findings was 15% ($n = 116$) and 21% ($n = 160$) were negative. Urologist has the highest positive yield of 67.4% ($n = 295$) followed by ER physician 67% ($n = 152$) and others 42.5% ($n = 43$); $p < 0.001$. Rate of incidental/alternate findings was highest in CT ordered by other specialties 23.7% ($n = 24$) followed by ER physician 17.6% ($n = 40$) and urologist 11.8% ($n = 52$); $p = 0.005$.
Conclusion: There is statistically significant difference of yield across specialties. CT KUB as an initial imaging modality for suspected urolithiasis should be ordered in consultation with the urologist and ER physicians. Tool of good history taking and physical examination has proved to be essential steps in algorithm of ordering CT KUB, which can avoid unnecessary radiation exposure.

1. Introduction

Reno-ureteral colic is a common presenting symptom in hospital emergency department and urology clinic. Lifetime incidence is 12% with very significant economical impact ($1.83 million per annum in USA alone).[1] CT KUB has emerged as reference standard in evaluation of suspected renal colic and has replaced IVU as investigation of choice.[2] It has been demonstrated in both observational and comparative studies, that this modality has a higher sensitivity and specificity for detection of stone and obstruction.[3] It can also reliably identify other abdominal conditions as a cause of acute flank pain.[4] However, over the past decade, trend of increase use of CT has markedly affected the radiology work flow. It has a serious economic impact and very high ionizing dose.[1]

As unenhanced CT (CT KUB) has become the primary imaging modality in evaluation of suspected renal colic, it is increasingly been used as a screening tool to rule out urolithiasis. It is not only ordered by urologists but also by other specialties. With its high sensitivity and specificity for detection of urolithiasis, it also carries risk of higher radiation exposure. Its rationale use is a contemporary question.

The purpose of our study is to assess the difference of positive yield of urolithiasis across different specialties, an indirect indicator of the fact that how justified we are in ordering CT KUB. It may also help in identifying the need to develop an algorithm to order CT when clinically indicated.

2. Materials and methods

Between 1st, January 2009 and 31st, December 2009, 1550 consecutive CT KUB examinations were ordered for evaluation of clinically suspected renal colic. Cases were identified from the radiology information system by using the study

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description of 'CT KUB'. All scans were either primarily read by a resident followed by a consultant radiologist or by a consultant radiologist directly.

The CT reports were retrospectively reviewed by the authors and were interpreted as 'diagnostic' for urolithiasis, with the presence of a urinary tract stone(s) or secondary signs of obstruction such as perinephric stranding, periureteral stranding, hydronephrosis and hydroureter. Each CT KUB was categorized into one of four groups: a 'diagnostic' CT showing urinary tract calculi or secondary signs of obstruction, a CT showing 'alternate' finding describing the cause of flank pain, CT with incidental finding which is unlikely to result in patients' clinical presentation; or a negative CT which is normal. CT KUB examinations with incidental and alternate findings were further classified into genitourinary (GU) and extra-genitourinary (EGU).

Only those CT KUB examinations done as primary imaging to evaluate acute flank pain were included in the study, examinations performed to refine a diagnosis or to further a diagnosis of stone and obstruction were excluded. Referring clinician were divided in three groups: (I) urologist/and senior urology residents (ii) consultant Emergency room physician (ER physician) and (iii) others i.e., general surgery, medicine, family medicine etc.

Exclusion criteria included all CT KUB examinations ordered by outside physician (as the required clinical information was not available), patient diagnosed to have urolithiasis in last 6 months and/or those who have any positive urological imaging in the last 6 months. Patients with missing data at any point were also excluded.

Follow-up radiology reports and discharge summaries on the hospital clinical Intranet were also reviewed. Studies were analyzed for characteristics including patient demographics, referring clinician and final diagnosis.

3. Statistical analysis

The data was analyzed using SPSS version 16. The chi-square test and analysis of variance comparison were used to compare rates of positive, negative and incidental findings as well as to compare yield across specialty.

4. Results

Of 1550 CT KUB examinations done during the study period, 766 met the inclusion criteria. 536 (70%) CT KUB examinations were of males while 230 (30%) were of females. Mean age (±Standard deviation) of the patients was 37.1 ± 12.4 years. Highest number of CT KUB examinations were ordered by urologists (57.2%, $n = 438$) followed by ER physician (29.6%, $n = 227$) and others (13.2%, $n = 101$), (Table 1). The overall positive yield for urolithiasis was 64% ($n = 490$), rate of incidental/alternate findings was 15.1% ($n = 116$) and 20.9% ($n = 160$) were negative. Urologist has the highest positive yield of 67.35% ($n = 295$) followed by ER physician 66.9% ($n = 152$) and others 42.5%($n = 43$); $p < 0.001$. Rate of incidental/alternate findings was highest in CT ordered by other specialties 23.7% ($n = 24$) followed by ER physician 17.6% ($n = 40$) and urologist 11.8% ($n = 52$); $p = 0.005$.

Of 490 diagnostic CT KUB examinations, 459 had renal, ureteric or both stones with or without secondary sign/s of obstruction while 31 CT KUB examinations had only secondary signs/s of obstruction (Table 2).

Nearly three-quarter ($n = 365$, 74.5%) CT KUB examinations were of males while 25.5% ($n = 125$) were of females. Female patients were more likely to have negative CT than males (45.6%, 105 out of 230 $p < 0.001$). Incidental findings were also more common in females (20.43%, 47 out of 230 $p = 0.01$). Incidental GU findings were seen in 29.6% ($n = 29$), EGU incidental findings were seen in 64.3% ($n = 63$) while 3.4% CT KUB examinations ($n = 4$) had both. Most common GU incidental finding was renal cyst 55% ($n = 16$) while most common EGU finding was spine pathology 41.2% ($n = 26$). Most common alternate finding was appendicitis, $n = 11$ (Table 3, Fig. 1).

Besides flank pain, 23% also had lower urinary tract symptoms (LUTS). Of them 92.4% ($n = 453$) had positive CT KUB examinations in comparisons to those who present with neither of these symptoms ($p = 0.05$), Fig. 3. Patients who had flank tenderness or costovertebral angle tenderness on renal punch were more likely to have positive CT scan ($p = 0.001$). There was a history of renal stone or LUTS in 26.7% ($n = 131$) CT positive patients while 13.7% ($n = 67$) had prior surgical intervention for urolithiasis, more than 6 months earlier. The presence of microscopic hematuria correlated well with the diagnosis of urolithiasis on CT and this was statistically significant ($p < 0.005$). There was a difference in the sensitivity, specificity of microhematuria in the two genders. The sensitivity, specificity, PPV and NPV in the males and females respectively were 68 and 70%, 62 and 56%, 80 and 65% and 47 and 61%.

Table 1
Yield of CT across specialty and gender distribution.

Specialty	Positive for urolithiasis/ obstruction	Negative for urolithiasis/ obstruction	Incidental/ Alternate		Male	Female
Urology	67.34%	20.77%	11.87%		70.54%	29.45%
	$n = 295$	$n = 91$	$n = 52$		$n = 309$	$n = 129$
ER	66.9%	15.4%	17.62%		71.36%	28.64%
	$n = 152$	$n = 35$	$n = 40$		$n = 164$	$n = 63$
Others	42.5%	33.6%	23.7%	$p = 0.001$	62.37%	37.63%
	$n = 43$	$n = 34$	$n = 24$		$n = 63$	$n = 38$

Table 2
Primary and secondary signs of urolithiasis.

Stone location	n (%)
Renal	190 (38.77)
Ureteric	199 (40.61)
Both	70 (14.28)
Secondary signs	**n (%)**
Hydronephrosis	6 (1.22)
Hydroureter	4 (0.81)
Perinephric/ureteric stranding	8 (1.63)
>1 sign	13 (2.65)

5. Discussion

Renal colic is a common presenting symptom in hospital emergency department and urology clinic.[5] Urolithiasis has a lifetime incidence of 12% with first five- to ten-year recurrence rate following single episode of renal stone exceeding 50%.[6,7] It is three times more common in males with common age of presentation between 30 and 60 years.[8]

Radiological imaging has a central role in the management of patients presenting with suspected acute renal colic. Choice of imaging modality depends on its accuracy, safety, cost-effectiveness, availability, adaptability and ease of interpretation. CT KUB

Table 3
Distribution of incidental and alternate findings.

GU	EGU
Incidental findings n (%)*	
Renal cyst 16 (55)	*Spine pathology 26 (41.2)*
Atrophic kidney 4 (14)	Spondylosis 5, fracture 6, compression 6, degenerative changes 7, multiple myeloma 1.
Renal mass 2 (7)	*Gynecological 18 (28.5)*
Extra renal pelvis 4 (14)	Ovarian cyst 13, fibroid uterus 5
Duplex collecting system 2 (7)	*Gastrointestinal 11 (17.4)*
Horse Shoe kidney 1 (3.4)	Fecal loading 2, hepatic cyst 2, enterolith 1, hepatoma 1, mesenteric cyst 3, diverticulosis 2
	Others 8 (12.7)
	Abdominal/pelvic lymphadenopathy 6, pleural effusion 2
Alternate findings (n)	
Ureteric stricture 2	Appendicitis 11, cholecystitis 5

* Four CT KUB examinations had both GU and EGU incidental findings.

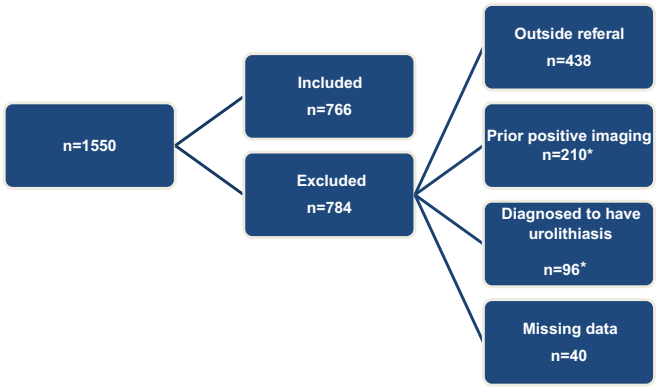

Fig. 1. Flow diagram for inclusion. *In past 6 months.

has a number of obvious advantages over the IVU. It is the imaging modality of choice for the diagnosis and follow-up of urolithiasis. With its superior sensitivity and specificity (96–100%, respectively),[9] an added advantage of CT over intravenous urography is its ability to distinguish renal colic from alternate causes of flank pain[10] thus significantly reduces the time they spend in the emergency department.[11] In view of the quality of CT KUB, lack of contrast is it cannot be used to exclude many urological conditions, including UPJ obstruction,[12] parenchymal lesions and differentiation of various types of mixed density cystic lesions, upper tract UCC, renal infarction[13] etc. It should best be considered as a screening tool for such conditions and specialized investigations be performed to exclude these urinary tract abnormalities. However CT is a high radiation technique so risk versus benefits should always be considered. Urolithiasis is a highly recurrent condition which further contributes to the concern regarding high radiation doses.[14] Udayasankar et al.[15] assessed the utility of ultra low dose abdominal–pelvic MDCT and noted that it provides rapid and reasonably accurate diagnostic information in patients with acute abdominal pain at a very low radiation dose.

Chowdhury et al. have reported decrease rate of urolithiasis in female as compare to male patients (27.5% vs. 57.5%) presented in ER with flank pain.[16] Our study also indicates that female patients are more likely to have gynecological pathology as a cause of flank pain (38.3%) which is significantly higher than reported in literature (6%).[11] Most of the incidental findings require additional imaging further increasing the radiation exposure. The incidental findings detected on CT can be diagnosed with careful history taking, examination, urinalysis and investigations that are not only cheap but also carries no or minimal ionizing dose. Kyriacos Patatas

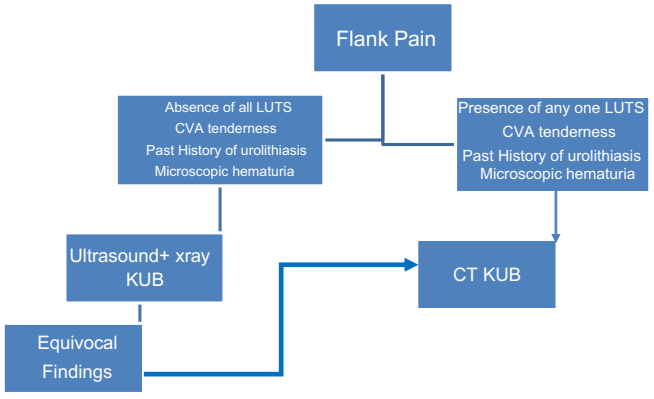

Fig. 2. Proposed algorithm for ordering CT KUB. KUB: Kidney, ureter bladder, CVA: Costo vertebral angle, LUTS: Lower urinary tract symptoms.

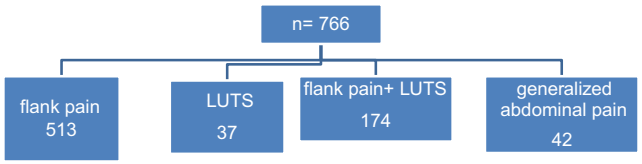

Fig. 3. Flow diagram describing the details of clinical presentation of patients included in the final analysis.

has suggested that when there is even the slightest doubt regarding a female patient's presenting symptoms and signs, she should be initially evaluated by other means (e.g., using a combination of plain radiography and ultrasound), thus avoiding the unnecessary use of CT.[5]

Buckley et al. have reported difference in the yield of diagnosis for urolithiasis across specialty.[17] Similar results are found in our study, urology and emergency department having a higher positive yield than other specialties, except that the gender distribution among all specialties is similar, male being more common.

The effective radiation doses of CT KUB reported by previous studies range between 2.8 and 9.2 mSv,[18–20] that is, 1.2–2.2 years background equivalent radiation time, assuming 2.4 mSv/year for natural background.[10] A report published in the New England J of Medicine stated that approximately one-third of all CT scans are not justified by medical need, and as many as 1.5–2% of all cancers in the USA might be caused by radiation from CT studies.[21]

Since urolithiasis is a recurrent condition with recurrence rates exceeding 35%, patients are likely to have repeat studies, with some patients having greater than 10 repeat studies over a 10-year period.[22] It is even more important to identify those patients who may benefit with this modality as initial investigation. The benefits of ionising radiation must always be considered against the potential risks of inducing cancer and other secondary effect.[4]

The awareness of physicians on radiation risk will definitely help in reducing patient exposure to potentially harmful ionizing radiation and reduce the lifetime risk of deleterious effect. A recently published study has proved that the education and training programme for radiological institutes is effective in achieving a substantial reduction in CT radiation dose.[23] The clinical application of lowering the dose could be considered in certain situations, such as in patients with known calculi >3 mm, in the reassessment of larger renal stones following endourological intervention or lithotripsy, or when calculi 3 mm or smaller are viewed as not clinically important due to their high probability of spontaneous passage.[14]

Clinical evaluation with history and physical examination along with urinalysis provides strong basis for clinical suspicion of urolithiasis and obstruction. Microscopic hematuria in the presence of acute flank pain is suggestive of renal colic, but the absence of red blood cells does not exclude urolithiasis. In our current work we found a statistically significant relationship between presence of stone on a CT and microscopic hematuria. In a recently reported work Lallas et al.[24] noted that presence of microscopic hematuria is dependent upon the stone size and location. Renal pelvic and ureteral stone and stones ≥8 mm are more likely to cause microhematuria than calyceal stone.[19] Our findings indicate a higher sensitivity, specificity and PPV of microhematuria in males, therefore it could be used as a clinical indicator of urolithiasis and patients could be evaluated with ultrasound scan rather than a CT. CT is useful if there is strong clinical suspicion; in equivocal cases screening could be done using ultrasound and plain X-ray KUB, which often suffice to make management decision.[25] Ather et al.[26] noted that ultrasound has sensitivity of over 80% and 100% specificity for renal stone but the sensitivity to pick ureteral stone is less

than half the cases, however, addition of plain X-ray increases the sensitivity to 77%. The sensitivity of the ultrasound scan is highly size dependant. For stones greater than 5 mm, the sensitivity matches that of CT scan, i.e. 96–100%.[27] However, for all locations and sizes the sensitivity and specificity of ultrasound reduces to 78% and 31% respectively.[21] It is therefore suggested that if there is incomplete information or equivocal findings CT could then be performed (Fig. 2), for most cases ultrasound and plain X-ray KUB suffice. Non-contrast enhanced CT is quick and requires very little preparation, therefore it is becoming the favored imaging for the ER physicians. It is particularly useful for a busy ER to quickly triage patient. However, this has increased the rate of negative CT. In view of the findings of the current work with nearly 2/3 CT KUB ordered by non-urologist and ER physicians, it is therefore recommended that CT should preferably be ordered by urology residents and by others in equivocal cases. Ultrasound with its inherent advantages of no radiation, cost-effectiveness and high sensitivity and specificity for renal, upper ureteral and ureterovesical junction stones should be first line imaging. Ultrasound along with plain X-ray KUB reaches sensitivity close to CT.

6. Conclusion

There is statistically significant difference of yield across specialties. CT KUB as an initial imaging modality for suspected urolithiasis should be ordered in consultation with the urologist and ER physicians. Tool of good history taking and physical examination has proved to be essential steps in algorithm of ordering CT KUB which can avoid unnecessary radiation exposure. The awareness of physicians on radiation risk will also help in reducing patient exposure to potentially harmful ionizing radiation. One of the limitations of the current work is the retrospective nature of data collection; the strength of recommendation would improve if the same work is performed prospectively in a multidisciplinary setting on a larger cohort.

Ethical approval

None.

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None.

Author contribution

M Nadeem: Study design, coordination of data collection, data analysis,

MH Ather: Study design, data analysis, manuscript writing.

A Jamshaid: Study design, data collection.

S Zaigham: Data collection.

R Mirza: Data collection.

B Salam: Data collection, data analysis particularly related to the radiological part.

Conflicts of interest

None.

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