Emergency department imaging protocol for suspected acute renal colic: re-evaluating our service

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Objectives: The objective of our study is to determine the positive rate for urolithiasis in male and female patients, and evaluate whether there has been any change at our institution in the use and outcome of unenhanced multidetector CT (CT KUB) performed in the emergency department (ER) for patients presenting with suspected acute renal colic.

Methods: A retrospective review of all 1357 consecutive cases between August 2007 and August 2009 admitted to the ER and investigated with CT KUB.

Results: The positive rate for urolithiasis was 47.5% and the rate of other significant findings was 10%. Female patients had a significantly lower positive rate than male patients (26.8% vs 61.6%, $p < 0.001$). Urological intervention was required in 37% and these patients had a larger average stone size. In young female patients with a significantly sized ureteric calculus (>4 mm), the presence of hydronephrosis vs no hydronephrosis was 83% vs 17%, respectively. Among them, only three patients required ureteroscopy for stone removal.

Conclusion: Contrary to other studies there has been no “indication creep” in the use of CT KUB at our institution. However, the young female patient presenting with suspected urolithiasis presents a particular diagnostic problem, and the significant percentage of negative examinations in females implies that an improvement in current practice is needed. The indiscriminate use of CT KUB in all female patients with flank pain should be avoided, and it is suggested that they should be initially evaluated with ultrasound to detect the presence of hydronephrosis.

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Acute flank pain due to suspected renal colic is a common clinical presentation in the accident and emergency department. Urolithiasis is estimated to have a lifetime incidence of 12% [1], usually presents in patients of 30–60 years of age and is approximately three times more common in males.

Unenhanced multidetector CT (CT KUB) is now firmly established as the best imaging method in the evaluation of suspected acute renal colic and is replacing intravenous urography (IVU) at an increasing number of hospitals. Numerous studies have shown that CT KUB is a diagnostically superior, safer, quicker and more cost-effective investigation for acute renal colic [2–5]. There is no need for intravenous contrast (and hence no risk of allergic or anaphylactic reaction, nor nephrotoxicity), the examination time is considerably shorter, there is increased sensitivity for the detection of calculi and other causes of pain can be detected. However, CT is a high-radiation-dose technique. The effective dose of CT KUB has been estimated to be between 3 and 5 mSv, which is up to three times that for IVU [6]. It is important to establish that requests are appropriate and that the test will provide information to improve patient diagnosis, treatment and management. With the advancement in radiological techniques and new scanners, there exists

not only the potential to improve the practice of diagnostic imaging, but also the risk to overuse radiation [7]. At our institution, IVU was officially replaced with CT KUB from January 2006. Patients with a clinical suspicion of acute renal colic are initially managed and investigated with CT KUB in an emergency department-led clinical decisions unit (CDU). The aim is to establish a diagnosis while managing symptoms. Any emergency department doctor can refer the patient for CT KUB if the patient has symptoms and signs suggestive of renal colic according to the referral pathway. The initial experience with the new imaging protocol was reported in a study by Chowdhury et al [8] between February and October 2006, which demonstrated the efficacy of CT KUB in the investigation and management of patients. However, it is not clear how the use of CT KUB at our hospital has changed since 2006, and we have anecdotally noticed an increase in the number of CT examinations being ordered for renal colic, especially in young female patients. Even in 2006 the positive rate for stone disease in female patients was considerably lower than for male patients (27.5 vs 57.5%, $p < 0.001$). There is a risk of CT KUB being used as a screening tool, given its ability to facilitate diagnosis of alternative pathologies. Chen et al [9] demonstrated the concept of “indication creep” when they compared the positive rate for urolithiasis at the time of introduction of CT KUB with that for 1 year later. They showed a significant decrease (from 49 to 28%) in the detection of urolithiasis and an increase (from 16 to

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45%) in the number of significant alternative diagnoses. Although the CDU protocol for suspected renal colic has a number of obvious advantages, including significantly reducing the time patients spend in the emergency department, it could also lead to unnecessary use of CT (with its inherently higher effective radiation dose in females) in young female patients with vague intermittent symptoms, gynaecological abnormality or urinary tract infection/pyelonephritis. It has been demonstrated that the effective dose (summation of tissue equivalent doses each multiplied by the appropriate tissue weighting factor) to males is significantly lower than that to females, owing to the anatomical position of the female gonads, which are completely exposed to radiation during the study, while male gonads lie outside of the exposed area and receive only diffuse radiation [6].

The inclusion criteria according to the protocol are a history consistent with renal/ureteric colic (e.g. loin pain radiating to groin), haematuria on urinalysis and

persisting pain. Urinary tract infection must be excluded (Figure 1).

The purpose of our study is to determine the positive rate for urolithiasis in male and female patients, and to evaluate whether there has been any change at our institution in the use and outcome of CT KUB performed in the emergency department for patients presenting with suspected renal colic.

Methods and materials

All 1357 consecutive cases of suspected acute renal colic admitted to the emergency department and investigated using CT KUB between August 2007 and August 2009 were identified retrospectively from the radiology department's electronic records. Ethical approval and patient consent are not required in our institution for retrospective studies of case series. The CT KUB reports, any pre-CT KUB imaging, follow-up

Figure 1. The management pathway for patients with suspected acute renal colic at our institution. AAA, abdominal aortic aneurysm; CDU, clinical decisions unit; CT KUB, unenhanced multidetector CT; UTI, urinary tract infection.

investigations and intervention in positive cases were obtained from the radiology information and management system, and multidisciplinary team plan. Data from multiple CT examinations performed in the same patient during the 2-year period were included as separate admission only if the clinical details and CT report suggested that the visit represented a new onset of renal colic and a previous obstructive stone had been passed by the patient prior to returning to the emergency department. All CT KUB examinations were either primarily or secondarily reviewed by a consultant radiologist. An unenhanced volume acquisition from xiphisternum to symphysis pubis was performed. Cases were defined as positive if high-attenuation calculi were detected in the kidney, ureter or bladder ipsilateral to the patient's symptoms. The maximal axial measurement of the calculus was recorded. In the absence of calculi, changes reported as likely to account for the recent passage of a calculus were recorded. Alternative diagnosis was defined as abnormality detected on CT KUB that accounted for the patient's symptoms or would require further evaluation. According to the findings, five diagnostic groups were made:

1. positive renal colic: calculus ipsilateral to the patient's symptoms clearly detected by CT
2. probable renal colic: no detectable calculus on the side of pain but signs indicating possible recent passage (hydronephrosis, ureteral dilatation, perinephric or periureteric stranding, swollen kidney)
3. equivocal: high-attenuation material in the line of the ureter but not definitely within the ureter
4. negative: no renal tract calculus ipsilateral to the patient's symptoms (includes contralateral renal calculi)
5. significant alternative diagnosis.

In positive cases—in addition to the axial measurement of the calculus—the location of the calculus (*i.e.* renal, ureteric or bladder) and the presence and degree of hydronephrosis were recorded.

Regarding the definition of positive cases, the clinical relevance of non-obstructing renal calculi ipsilateral to the patient's symptoms (which in our study were included in the positive group) is still debated. Furlan et al [10] showed in a retrospective study that 18% of patients investigated for renal colic with CT KUB had a non-obstructing renal stone on the same side as the pain as the only CT finding. Approximately half of those patients had multiple previous or subsequent emergency department admissions and CT examinations for the same symptoms. In addition, 74% of patients were positive for haematuria, suggesting that these calculi were the cause of the patients' pain and haematuria. Other investigators have suggested that a small renal stone may intermittently obstruct at the pelviureteric junction or at the calyceal level, potentially causing epithelial irritation with pain and haematuria. The CT signs of intermittent or intrarenal obstruction would be minimal or absent. Brannen et al [11] reported that 34 out of 36 patients with non-obstructing calculi reported complete resolution of their pain once the calculus was removed by a percutaneous technique. At our institution a significant number of patients with non-obstructing

renal calculi are treated with extracorporeal shock wave lithotripsy.

Statistical analysis

The χ^2 test was used to compare positive rates between male and female patients. The Student's *t*-test was used for comparison of calculus size between the intervention and non-intervention group. Statistical analysis was performed using the SPSS® software package (v. 12 for Windows; SPSS, Chicago, IL).

Results

A total of 1357 patients underwent CT KUB through the suspected acute renal colic imaging pathway between August 2007 and August 2009, of whom 59.3% (805/1357) were male and 40.7% (552/1357) female. The average age was 42 years (range, 16–92 years). The overall positive rate for ipsilateral calculus was 47.5% (644/1357). A further 136 out of 1357 (10.0%) had an alternative significant diagnosis. The positive rate in males was 61.6% (496/805), with a rate of other significant findings of 7.7% (62/805). By contrast, the positive rate in females was lower at 26.8% (148/552) and the rate of other significant findings was 13.4% (74/552). The difference between the male and female positive rate was statistically significant ($p < 0.001$). There was no statistical significance between the rate of alternative findings in male and female patients. The positive rate in female patients aged <45 years was 24.1% (91/378), whereas in females aged >46 years the positive rate was 32.8% (57/174). In females, a gynaecological abnormality was the commonest alternative diagnosis (36.5%, 27/74), of which more than half (15/27) were an ovarian cyst of significant size. In males, the 2 commonest diagnoses were diverticulitis (24.2%, 15/62) and appendicitis (14.5%, 9/62). The rate of equivocal result was 1.2% (16/1357) and the rate of probable renal colic was 0.7% (10/1357).

Urological intervention was required in 37.3% (240/644) of cases, while 62.7% (404/644) were managed conservatively. The average stone size in the treated group *vs* the group managed conservatively was 7 *vs* 3.9 mm ($p < 0.001$). 81.3% (195/240) had ureteroscopy, 34.6% (83/240) lithotripsy, 7.1% (17/240) nephrostomy and 3.3% (8/240) percutaneous nephrolithotomy. The

Table 1. Type of follow-up imaging in the group managed conservatively

Follow-up imaging	Conservative management group, <i>n</i> (total=404)	%
No follow-up	144	35.6
PF only	134	33.2
Ultrasound only	23	5.7
CT only	6	1.5
PF plus ultrasound	53	13.1
PF plus CT	36	8.9
PF plus ultrasound plus CT	6	1.5
Ultrasound plus CT	2	0.5

PF, plain film.

type of follow-up investigations in the group managed conservatively was variable (Table 1).

Only 2 out of 1357 patients (both female) had ultrasound prior to CT KUB. Of the 148 positive female patients, 108 (73.0%) had ureteric calculi. From this group, 67 patients were aged <45 years, and 61.2% (41/67) had hydronephrosis on CT KUB (therefore would have been detected by ultrasound). In young female patients (41 patients) with a significant ureteric calculus (>4mm), the presence of hydronephrosis *vs* no hydronephrosis was 82.9% (34/41) *vs* 17.1% (7/41), respectively. Among them, only three patients (7.3%) required ureteroscopy for stone removal.

Discussion

The previous study at our institution in 2006 [8] showed an overall positive rate of 44%, with a significantly lower female than male positive rate (27.5% *vs* 57.5%, respectively). The rate of alternative diagnosis was 12%. In another retrospective review of 156 patients at the Royal Infirmary of Edinburgh, the positive rate in males was 55%, while female patients had a much lower positive rate at 18% [12]. The results of our study are in accordance with the 2006 study, with an overall positive rate of 47.5%, female positive rate of 26.8% and male positive rate of 61.6%. The rate of alternative diagnosis is also essentially unchanged (10% in our study *vs* 12% in 2006) and consistent, but at the lower end of the range, with a quoted range of 9–29% for patients presenting with flank pain [13].

CT KUB allows a rapid, contrast-free, anatomically accurate diagnosis of urolithiasis with a sensitivity of 97–98% and a specificity of 96–100% [14]. It has become the gold standard in the imaging of suspected acute renal colic. At our institution, since the introduction of the new imaging pathway, the use of CT KUB represents a substantial proportion of the acute CT workload. A significant number of these examinations are performed out of hours by the on-call radiologist. The number of CT scanners for accident and emergency patients or inpatients has also increased across the two hospitals, but this change was made to cope with generally increased demands rather than specifically for patients with suspected renal colic.

An important issue that has arisen with the use of CT KUB for acute flank pain is the expansion of the indications for the examination beyond the specific evaluation of urolithiasis. Our study shows that there has been no indication creep, in accordance with other investigators [1] and in contrast to Chen et al [9].

The female patient presenting at the accident and emergency department with suspected renal colic presents a particular diagnostic problem. As we have shown, the positive rate is considerably lower than in male patients. Interestingly, 58.2% (321/552) of the CT examinations in female patients were completely normal (positive rate, 148/552, 26.8%; alternative diagnosis, 74/552, 13.4%; equivocal, 9/552, 1.6%). The positive rate was even lower for young female patients (<45 years of age), with a positive rate of 24.1% *vs* 32.8% for female patients aged >46 years. Of the young female patients with a significant ureteric calculus (>4mm) only 17.1% (7/41)

did not have hydronephrosis (therefore would not have been detected by ultrasound), and only 7.3% (3/41) did not settle on conservative management and needed ureteroscopy. It could be speculated that they should be initially evaluated by ultrasound to detect the presence of hydronephrosis. A prospective study [15] comparing plain film and sonography *vs* CT KUB showed that in all cases where the calculus was not visualised by X-ray plus ultrasound, the patient passed the stone spontaneously (90% of patients had a stone <5mm). These authors recommended that in a setting of a negative plain film ultrasound examination CT should be reserved for patients not improving on conservative management. It has also been established that calculi <5mm have a >80% likelihood of passing spontaneously [16], and over 80% of stones ≤4mm at the vesicoureteric junction will pass spontaneously [17].

Ultrasound would also show many of the alternative findings discovered on CT KUB. Even when a gynaecological abnormality is detected on CT, it usually requires further evaluation by other imaging modalities such as ultrasound or MRI.

Conclusion

CT KUB is a rapid and accurate diagnostic test for suspected acute renal colic. Contrary to other studies, there has been no indication creep in the use of CT KUB at our institution. The significant percentage of negative CT KUB in female patients implies that an improvement in current practice is needed. Good clinical assessment with an attempt to exclude other diagnoses (for example urinary tract infection) and consideration of ultrasound as first-line investigation in young female patients would avoid patients being exposed to unnecessary radiation. The indiscriminate use of the CDU protocol and CT KUB in all female patients with flank pain should be avoided.

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