The diagnostic yield of computed tomography in the management of acute flank pain and the emergency intervention rate for a proven acute ureteric stone

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ABSTRACT

INTRODUCTION The diagnostic and management pathways for patients presenting with acute flank pain are complex. Although computed tomography (CT) of the kidneys, ureters and bladder (KUB) is the gold standard investigation for urolithiasis, the multitude of differential diagnoses must also be considered in the context of long-term risk from ionising radiation. This study investigated the integrated role and diagnostic yield of non-contrast CT in cases of acute flank pain.

METHODS A retrospective cohort study was undertaken of 1,442 consecutive patients investigated with CT KUB between March 2013 and February 2015. The primary outcome was diagnostic yield of CT with secondary outcomes being predictors of need for urological intervention.

RESULTS A cause for acute flank pain was identified in 717 patients (50%), there was an incidental finding in 389 patients (27%) and normal imaging was reported in 336 patients (23%). A diagnosis was more commonly made in male than in female patients (70% vs 40%) and with increasing age (46% in patients aged <30 years, 56% in those aged 30–49 years and 63% in those aged ≥50 years). The overall rate for an ipsilateral urinary tract stone was 41%. Factors strongly associated with emergency intervention included stone size >10mm (odds ratio [OR]: 11.7, 95% confidence interval [CI]: 3.3–42.7), stones located at the pelviureteric junction (OR: 7.8, 95% CI: 2.6–22.9), C-reactive protein >50mg/l and ≤100mg/l (OR: 15.2, 95% CI: 5.1–45.3), and estimated glomerular filtration rate ≤30ml/min (OR: 5.8, 95% CI: 1.5–21.8).

CONCLUSIONS This contemporary study identifies age and sex as independent variables affecting the diagnostic yield of CT KUB in cases of acute flank pain, and highlights factors associated with a need for emergency intervention in proven ureteric stones.

KEYWORDS

Computed tomography – Kidneys, ureters and bladder – Flank pain

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Acute flank pain is a common presenting complaint in both the primary and secondary care settings. Despite the range of potential aetiologies for flank pain, there is convincing evidence that urinary tract stone disease is becoming an increasing and significant healthcare burden.¹ Much of the literature focuses on the management of proven ureteric calculi but an alternative diagnosis or indeed no diagnosis is possible in this group of patients.

Multidetector computed tomography (CT) of the kidneys, ureters and bladder (KUB) is now the gold standard investigation for stones in patients presenting with acute flank pain, with sensitivity of 90–97% and specificity of 86–100%.^{2,3} Modern imaging studies also suggest a low radiation dose of between 0.9mSv and 1.5mSv.⁴ However,

widespread use of CT in the US is predicted to be the cause of 1.5–2% of all future cancer diagnoses.⁵ The long latency period between exposure to radiation and development of solid cancer puts younger patients at highest risk, with a further increase in susceptibility in female patients.^{5,6}

Previous studies with smaller cohort numbers have reported alternative diagnoses in patients labelled as having ‘ureteric colic’ in 3–10% of cases.^{7–10} Attempts have also been made to risk stratify proven ureteric stones in order to aid management by predicting intervention or spontaneous passage.^{11–15}

To date, publications have focused very much on a urological diagnosis. The aim of the present study was to give clinicians and patients objective data to help them understand

the implications at each stage of management, accounting for different demographics, and the need for intervention with acute ureteric stones.

Methods

A retrospective cohort study was undertaken of all consecutive patients receiving non-contrast CT KUB for investigation of acute flank pain at a large acute hospital (serving a local population of 675,000) between March 2013 and February 2015. Data were acquired from electronic CT requests, radiological reports and clinical records to determine the indication for CT. The primary outcome measure was diagnostic yield for an acute, non-acute and negative diagnosis in patients with CT performed for acute flank pain, stratified by age and sex. The secondary outcome measure was emergency intervention following an episode of acute ureteric colic. This was defined as an unplanned intervention that resulted from an acute admission and included ureteroscopy (URS), ureteric stent or nephrostomy insertion.

Patient demographics recorded were age, sex, indication for CT KUB, side of pain, serum inflammatory markers (white cell count [WCC] and C-reactive protein [CRP]), renal function (serum estimated glomerular filtration rate [eGFR]), need for admission and length of stay. CT findings on stone size (maximal axial diameter), stone location and any alternative cause for acute pain were detailed. Stone position was recorded as pelviureteric junction, ureteric (proximal, middle or distal) or vesicoureteric junction. If more than one stone was present, the most proximal and largest was included in the analysis. Furthermore, data were collected on the indication for and type of emergency intervention in patients with an ureteric stone as well on patients who were managed conservatively or treated electively.

For comparative analysis, some factors were subcategorised. These comprised age (<30 years, ≥30 years and <50 years, ≥50 years), stone size (<4mm, ≥4mm and <6mm, ≥6mm and <10mm, ≥10mm), WCC ($\leq 10 \times 10^9/l$, >10 and $\leq 15 \times 10^9/l$, $>15 \times 10^9/l$), CRP ($\leq 50\text{mg/l}$, $>50\text{mg/l}$ and $\leq 100\text{mg/l}$, $>100\text{mg/l}$) and eGFR ($\leq 30\text{ml/min}$, $>30\text{ml/min}$ and $\leq 60\text{ml/min}$, $>60\text{ml/min}$).

Statistical analysis

Differences were compared where appropriate using Student's t-test, the chi-squared test or the Mann-Whitney U test. All tests were two-sided and a *p*-value of <0.05 was considered statistically significant. All analyses were performed using SPSS® version 22 (IBM, New York, US).

Univariate and multivariate logistic regression analysis was performed between the intervention and no intervention groups. This examined all patient and CT KUB characteristics to assess for factors that predicted emergency intervention.

Results

A total of 2,781 non-contrast CT KUB scans were performed during the study period, of which 1,442 (52%) were

undertaken for acute flank pain. An acute cause for the pain was identified in 50% (717/1,442), there were incidental findings in 27% (389/1,442) and a normal scan was reported in 23% (336/1,442) (Table 1).

Table 1 Radiological findings in patients with acute flank pain

Findings	Frequency
Acute cause for flank pain	717 (49.7%)
Aortic aneurysm	1 (0.1%)
Appendicitis	15 (1.0%)
Bladder stone	1 (0.1%)
Common bile duct obstruction	1 (0.1%)
Cholecystitis	1 (0.1%)
Colitis	2 (0.3%)
Consolidation	9 (0.6%)
Diverticular perforation	4 (0.6%)
Diverticulitis	14 (0.6%)
Duodenal perforation	1 (0.1%)
Faecal loading	2 (0.3%)
Hydronephrosis	12 (0.8%)
Hydrosalpinx	1 (0.1%)
Incisional hernia	1 (0.1%)
Ischaemic bowel	1 (0.1%)
Mesenteric lymphadenitis	2 (0.1%)
Ovarian abscess	1 (0.1%)
Pancreatitis	4 (0.6%)
Pelvic inflammatory disease	1 (0.1%)
Pelviureteric junction obstruction	7 (0.5%)
Pleural effusion	4 (0.6%)
Pneumonia	1 (0.1%)
Pyelonephritis	34 (2.4%)
Small bowel obstruction	4 (0.6%)
Ureteric stone	589 (40.8%)
Ureteric stricture	3 (0.4%)
Volvulus	1 (0.1%)
Incidental finding	389 (27.0%)
Adrenal mass	7 (0.5%)
Angiomyolipoma	2 (0.1%)
Atrophic kidney	4 (0.3%)
Bladder urothelial carcinoma	1 (0.1%)
Dermoid cyst	4 (0.3%)
Diverticular disease	51 (3.5%)

Table 1 (Continued)	
Findings	Frequency
Duplex kidney	2 (0.1%)
Fibroid	5 (0.3%)
Gallstone	28 (1.9%)
Hepatomegaly	2 (0.1%)
Hiatus hernia	1 (0.1%)
Horseshoe kidney	2 (0.5%)
Liver cyst	17 (1.2%)
Lymphadenopathy	2 (0.1%)
Medullary sponge kidney	1 (0.1%)
Mesenteric cyst	1 (0.1%)
Ovarian cyst	32 (2.2%)
Paraumbilical hernia	2 (0.1%)
Renal cell carcinoma	2 (0.1%)
Renal cyst	42 (2.9%)
Renal stone	173 (12.0%)
Spondylolisthesis	6 (0.4%)
Urachal remnant	1 (0.1%)
Ureteric urothelial carcinoma	1 (0.1%)
No cause found for flank pain	336 (23.3%)

Among the patients with an identifiable acute cause for flank pain, 90% (646/717) had a urological diagnosis, with a ureteric stone being the most common finding (82%, 589/717). A general surgical cause was identified in 7.4% of cases (53/717), a respiratory cause in 1.8% (13/717), a gynaecological cause in 0.4% (3/717), a vascular cause in 0.1% (1/717) and an orthopaedic cause in 0.1% (1/717) (Table 2).

Table 3 shows the CT findings grouped by age and sex. An acute cause for flank pain was found in 70% of male (508/728) and 40% of female patients (208/525). Within age groups, the acute diagnosis rate was 46% (102/222) in patients aged <30 years, 56% (268/483) in those aged 30–49 years and 65% (346/547) in those aged ≥50 years. When the study cohort was stratified by sex and age groups, male patients aged ≥50 years had the highest rate of an acute diagnosis (75%, 262/350) and the lowest negative CT rate (9%, 32/350).

Of the patients with a negative CT result, 60% (191/320) were female. Within age groups, the negative CT rate was 40% (89/222) in patients aged <30 years, 31% (150/483) in patients aged 30–49 years and 14% (81/547) in patients aged ≥50 years. Female patients aged <30 years had the highest rate of a normal scan (46%, 52/112).

A urinary tract stone was found in 53% of the total cohort (762/1,442). Three-quarters (77%, 589/762) were ureteric and 173 (23%) were renal calculi.

The overall positive rate for an ipsilateral calculus was 41% (589/1,442). Three-quarters of these (76%, 448/589)

Table 2 Acute cause for flank pain by specialty team (n=717)	
Cause	Frequency
Urology	646 (90.2%)
Bladder stone	1 (0.1%)
Unexplained hydronephrosis	12 (1.7%)
Pelviureteric junction obstruction	7 (1.0%)
Pyelonephritis	34 (4.7%)
Ureteric stone	589 (82.3%)
Ureteric stricture	3 (0.4%)
General surgery	53 (7.4%)
Appendicitis	15 (2.1%)
Cholecystitis	1 (0.1%)
Colitis	2 (0.3%)
Common bile duct obstruction	1 (0.1%)
Diverticular perforation	4 (0.6%)
Diverticulitis	14 (2.0%)
Duodenal perforation	1 (0.1%)
Faecal loading	2 (0.3%)
Incisional hernia	1 (0.1%)
Ischaemic bowel	1 (0.1%)
Mesenteric lymphadenitis	2 (0.3%)
Pancreatitis	4 (0.6%)
Small bowel obstruction	4 (0.6%)
Volvulus	1 (0.1%)
Respiratory	13 (1.8%)
Pleural effusion	4 (0.6%)
Pneumonia	9 (1.3%)
Gynaecology	3 (0.4%)
Hydrosalpinx	1 (0.1%)
Ovarian abscess	1 (0.1%)
Pelvic inflammatory disease	1 (0.1%)
Vascular	1 (0.1%)
Aortic aneurysm	1 (0.1%)
Orthopaedic	1 (0.1%)
Vertebral fracture	1 (0.1%)

were male, over half (57%, 337/589) were left-sided and three-quarters (76%, 450/589) were admitted to hospital with a mean length of stay of 2.8 days.

The mean age for this cohort was 49 years (interquartile range [IQR]: 38–60 years). The median stone size was 5mm (IQR: 3–7mm) with the most common site being the vesicoureteric junction (41%, 242/589). The overall emergency intervention rate for patients with an acute ureteric stone

Table 3 Computed tomography findings stratified by age and sex

Age (years)	Sex	Acute ^a	Incidental ^b	Normal ^c	Total
<30	Female	36 (32.1%)	24 (21.4%)	52 (46.4%)	112
	Male	66 (60.0%)	7 (6.4%)	37 (33.6%)	110
	Total	102 (45.9%)	31 (14.0%)	89 (40.1%)	222
≥30 and <50	Female	88 (40.7%)	38 (17.6%)	90 (41.7%)	216
	Male	180 (67.4%)	27 (10.1%)	60 (22.5%)	267
	Total	268 (55.5%)	65 (13.5%)	150 (31.1%)	483
≥50	Female	84 (42.6%)	64 (32.5%)	49 (24.9%)	197
	Male	262 (74.9%)	56 (16.0%)	32 (9.1%)	350
	Total	346 (63.3%)	120 (21.9%)	81 (14.8%)	547
All ages	Female	208 (39.6%)	126 (24.0%)	191 (36.4%)	525
	Male	508 (69.9%)	90 (12.4%)	129 (17.7%)	727
	Total	716 (57.2%)	216 (17.3%)	320 (25.6%)	1,252

^aData missing on age and/or sex for 1 patient
^bData missing on age and/or sex for 173 patient
^cData missing on age and/or sex for 16 patient

was 18% (104/589). Among patients undergoing emergency intervention, 59 (57%) had a ureteric stent, 21 (20%) had a nephrostomy, 21 (20%) had primary URS, 2 (2%) had extracorporeal shock wave lithotripsy and 1 (1%) had an emergency nephrectomy.

Patients who did not receive an emergency intervention received either medical expulsion therapy ($n=429$, 73%) or were listed for an elective procedure ($n=56$, 10%). Of the patients who received medical expulsion therapy, 60% (259/429) passed their stone spontaneously. Of the patients who had planned elective URS ($n=52$), spontaneous stone passage was reported in 7.7% (4/52), negative URS in 13.5% (7/52), failed ureteric access in 9.6% (5/52) and successful URS in 61.5% (32/52). One individual was stented owing to pyonephrosis (1.9%). Full details on the initial management and treatment outcomes of patients with an acute ureteric stone are given in Table 4.

Table 5 illustrates the differences in the baseline patient and CT characteristics for patients with a ureteric stone. The emergency intervention group was older (mean age: 54 vs 48 years, $p<0.05$), had higher CRP (mean CRP: 104mg/l vs 14mg/l, $p<0.0001$) and lower eGFR (mean eGFR: 55ml/min vs 71ml/min, $p<0.0001$), and were more likely to have larger stones (mean stone size: 9.1mm vs 4.8mm, $p<0.0001$) located in the upper ureter/pelviureteric junction (67% vs 23%, $p<0.0001$) compared with those who received no intervention. There was no difference in the mean WCC ($11.5 \times 10^9/l$ and $11.2 \times 10^9/l$ for the intervention and no intervention groups respectively, $p=0.67$) or the side of the stone ($p=0.09$). In the intervention group, significantly more male patients were treated than female patients (64% vs 36%, $p=0.02$) and there was a trend towards left-sided stones requiring emergency intervention (64% vs 34%).

Univariate and multivariate logistic regression analysis comparing patient and CT characteristics between both groups is summarised in Table 6. Multivariate analysis revealed that factors demonstrating the strongest association with emergency intervention comprised stone size >10mm (odds ratio [OR]: 11.7, 95% confidence interval [CI]: 3.3–42.7), stones located at the pelviureteric junction (OR: 7.8, 95% CI: 2.6–22.9), CRP >50mg/l and ≤100mg/l (OR: 15.2, 95% CI: 5.1–45.3) and eGFR ≤30ml/min (OR: 5.8, 95% CI: 1.5–21.8). There was no association between raised WCC or the laterality of the stone and the need for intervention.

Discussion

The data from our study can aid clinicians in decision making and explaining management options to patients with acute flank pain. An acute cause for the pain was found in only 70% of male and 40% of female patients. Of the 646 cases with an identifiable acute cause for flank pain, 90% had a urological diagnosis, with a ureteric stone being the most common finding and 18% progressing to require emergency intervention. The diagnostic yield of CT KUB was lowest in the young female patient group (ie those at the highest lifelong cancer risk from exposure to ionising radiation).^{5,6} Interest in ultrasonography to investigate flank pain has also made a recent resurgence and this may be especially relevant to reduce radiation dose in patients at low risk of forming stones.^{16,17}

The radiographic evaluation of acute flank pain and the diagnostic yield of CT has been reported by numerous authors. A large retrospective cohort of 254,211 US patients from 444 hospitals (which represented 15–20% of all US emergency department visits) underwent CT.¹⁸ The

Table 4 Initial management and treatment outcomes for patients with a ureteric stone (*n*=589)

Management and outcomes	Frequency
Medical expulsion therapy	429 (72.8%)
Spontaneous stone passage	259 (60.4%)
Elective URS	21 (3.6%)
Elective ESWL	1 (0.2%)
Unrelated death	2 (0.5%)
Medically unfit for treatment	5 (1.2%)
Did not attend follow-up clinic	35 (8.2%)
Unknown	106 (24.7%)
Emergency stent	59 (10.0%)
Elective URS	40 (78.8%)
Elective PCNL	4 (6.8%)
Elective ESWL	2 (3.4%)
Passed stone spontaneously	3 (5.1%)
Unknown	9 (15.3)
Did not attend follow-up clinic	1 (1.7%)
Elective URS	52 (8.8%)
Spontaneous passage prior to treatment	4 (7.7%)
Stone free at end of first treatment	32 (61.5%)
Stented (pus drained)	1 (1.9%)
Stented (failed access to ureter)	5 (9.6%)
Negative URS	7 (13.5%)
Emergency URS	21 (3.6%)
Stone free	16 (76.2%)
Unknown	5 (23.8%)
Emergency nephrostomy	21 (3.6%)
Elective URS	12 (57.1%)
Elective PCNL	4 (19.0%)
Conservative	4 (19.0%)
Elective nephrectomy	1 (4.8%)
Elective ESWL	2 (0.3%)
Stone free at end of treatment	2 (100%)
Emergency ESWL	2 (0.3%)
Unknown	2 (100%)
Elective PCNL	2 (0.3%)
Stone free	1 (50.0%)
Completion ESWL	1 (50.0%)
Emergency nephrectomy	1 (0.2%)

ESWL = extracorporeal shock wave lithotripsy; PCNL = percutaneous nephrolithotomy; URS = ureteroscopy

majority (91%) followed a non-contrast renal stone protocol. Overall, 19% of patients were admitted but a two-fold variability in the admission rates between hospitals suggested that hospital level factors may have influenced patient management. Intervention took place in 9.8% of cases; insured and older patients were more likely to be admitted, and once admitted, the insured patients were more likely to undergo intervention.

A retrospective multicentre UK study (MIMIC) has also addressed the role of raised inflammatory markers in spontaneous stone passage following CT diagnosis.¹⁹ Formal publication is awaited but preliminary data have been presented on 4,181 patients from 71 hospitals. Of these, 1,041 patients (24.9%) underwent immediate intervention but 611 (14.6%) were lost to follow-up or had no confirmed outcome. Of the remaining 2,516 patients available for analysis, 74.0% achieved spontaneous stone passage. As with previous studies,²⁰ the strongest predictors for spontaneous passage were stone size and location. WCC alone was not shown to influence outcome.

A UK series of 1,357 cases with CT performed for suspected renal colic revealed a positive rate for urolithiasis of 47.5%, with the rate of other significant findings being 10%.⁹ Again, female patients had a significantly lower positive rate than male patients (26.8% vs 61.6%, *p*<0.001). Intervention was required in 37%, which tended to be those patients with larger stones. Hydronephrosis was present in 83% of young female patients with a ureteric calculus of >4mm. Only three of these individuals required URS for stone removal.

In a small Canadian retrospective series of 195 patients who presented with a ureteric calculus, 41% underwent intervention based on CT evidence of ureteric obstruction.²¹ Stone size, a more proximal location and severe pain were associated with intervention but the degree of obstruction (a highly subjective measurement) did not influence management. Interestingly, none of the variables studied were predictive of readmission within 30 days.

In the US, data from a series of 686 patients (343 with distal and 343 with proximal ureteric stones) were reported.²² Logistic regression analysis again demonstrated that patients with proximal stones, larger stones and higher pain intensity were more likely to choose URS than medical expulsive therapy.

Conclusions

If an individual presents with acute flank pain suggestive of renal colic, there is only a 41% chance of detecting a ureteric stone, with significant differences depending on age and sex. There is also a 23% chance of normal CT results.

Young female patients presenting with suspected urolithiasis pose a particular diagnostic problem. Furthermore, the significant percentage of negative examinations in female patients implies potential for improvement in the current criteria for use of CT KUB (or alternative imaging modalities) in subgroups of patients with flank pain. The intervention rate of 18% for an acute ureteric stone can

Table 5 Baseline patient and computed tomography characteristics for patients with a ureteric stone

Variable	Total (n=589)	No intervention (n=485, 82%)	Intervention (n=104, 18%)	p-value*
Sex				0.02
Male	448 (76%)	381 (79%)	67 (64%)	
Female	141 (24%)	104 (21%)	37 (36%)	
Age (years)				<0.05
<30	77 (13%)	68 (14%)	9 (9%)	
≥30 and <50	216 (37%)	184 (38%)	32 (31%)	
≥50	296 (50%)	233 (48%)	63 (61%)	
Mean (median)	49 (50)	48 (48)	54 (54)	
IQR	38–60	36–59	42–67	
Range	16–89	16–87	18–89	
Side				0.09
Left	337 (57%)	271 (56%)	66 (64%)	
Right	247 (42%)	212 (44%)	35 (34%)	
Bilateral	5 (1%)	2 (0.2%)	3 (3%)	
Stone size (mm)				<0.0001
≤4	258 (44%)	249 (51%)	9 (9%)	
>4 and ≤6	180 (31%)	153 (32%)	27 (26%)	
>6 and ≤10	113 (19%)	69 (14%)	44 (42%)	
>10	38 (7%)	14 (3%)	24 (23%)	
Mean (median)	5.6 (5)	4.8 (4)	9.1 (8)	
IQR	3–7	3–6	6–10	
Range	1–40	1–23	3–40	
Stone location				<0.0001
VUJ	242 (41%)	229 (47%)	13 (13%)	
Lower ureter	125 (21%)	112 (23%)	13 (13%)	
Middle ureter	39 (7%)	31 (6%)	8 (8%)	
Upper ureter	125 (21%)	88 (18%)	37 (36%)	
PUJ	58 (10%)	25 (5%)	33 (31%)	
WCC ($\times 10^9/l$)**				0.13
≤10	240 (43%)	194 (42%)	46 (46%)	
>10 and ≤15	250 (44%)	213 (46%)	37 (37%)	
>15	73 (13%)	55 (12%)	18 (18%)	
Mean (median)	11.3 (10.8)	11.2 (10.9)	11.5 (10.3)	
IQR	3.1–8.3	8.3–13.5	7.7–13.2	
Range	1.9–129	2–129	4–39	
CRP (mg/l)**				<0.0001
≤50	465 (85%)	418 (94%)	47 (46%)	
>50 and ≤100	26 (5%)	8 (2%)	18 (18%)	
>100	56 (10%)	18 (4%)	38 (37%)	
Mean (median)	30.6 (4)	14 (3)	103 (64)	
IQR	2–15	1–8	12–148	
Range	3–422	3–422	3–418	
eGFR (ml/min)**				<0.0001

Table 5 (Continued)

Variable	Total (n=589)	No intervention (n=485, 82%)	Intervention (n=104, 18%)	p-value*
≤30	23 (4%)	6 (1%)	17 (16%)	
>30 and ≤60	136 (24%)	95 (20%)	41 (39%)	
>60	410 (72%)	364 (78%)	46 (44%)	
Mean (median)	68.2 (72)	71 (73)	55 (53)	
IQR	57–84	61–85	34–78	
Range	3–90	6–90	4–90	

CRP = C-reactive protein; eGFR = estimated glomerular filtration rate; IQR = interquartile range; PUJ = pelviureteric junction; VUJ = vesicoureteric junction; WCC = white cell count
 *Chi-squared test of heterogeneity between groups
 **Missing data for WCC (n=26), CRP (n=42) and eGFR (n=20)

Table 6 Univariate and multivariate logistic regression model showing odds ratio with 95% confidence interval for factors predictive of emergency intervention

Variable	Univariate	Multivariate
Sex (ref female)		
Male	2.1 (1.3–3.2), p=0.002	0.6 (0.3–1.3), p=0.18
Age (years) (ref <30)		
≥30 and <50	1.3 (0.6–2.8), p=0.49	1.3 (0.5–3.8), p=0.59
≥50	2.0 (1.0–4.3), p=0.06	0.7 (0.3–2.2), p=0.59
Side (ref left)		
Right	0.7 (0.4–1.1), p=0.09	0.8 (0.4–1.6), p=0.55
Stone size (mm) (ref ≤4)		
>4 and ≤6	4.9 (2.4–10.7), p<0.0001	2.9 (1.2–7.4), p=0.02
>6 and ≤10	17.6 (8.2–37.9), p<0.0001	7.1 (2.8–17.9), p<0.0001
>10	47.4 (18.6–120.9), p<0.0001	11.7 (3.3–42.7), p<0.0001
Stone location (ref VUJ)		
Lower ureter	2.1 (0.9–4.6), p=0.08	1.6 (0.6–4.4), p=0.36
Middle ureter	4.5 (1.8–11.8), p=0.002	3.2 (0.9–12.1), p=0.08
Upper ureter	7.4 (3.8–14.6), p<0.0001	6.4 (2.6–22.9), p<0.0001
PUJ	23.3 (10.8–49.9), p<0.0001	7.8 (2.6–22.9), p<0.0001
WCC ($\times 10^9/l$) (ref ≤10)		
>10 and ≤15	0.7 (0.5–1.2), p=0.73	0.7 (0.4–1.4), p=0.38
>15	1.4 (0.7–2.6), p=0.31	0.8 (0.3–2.1), p=0.64
CRP (mg/l) (ref ≤50)		
>50 and ≤100	20.1 (8.3–48.6), p<0.0001	15.2 (5.1–45.3), p<0.0001
>100	18.8 (9.9–35.5), p<0.0001	10.9 (4.6–26.3), p<0.0001
eGFR (ml/min) (ref >60)		
>30 and ≤60	3.4 (2.1–5.5), p<0.0001	2.8 (1.4–5.7), p<0.0001
≤30	22.4 (8.5–59.7) p<0.001	5.8 (1.5–21.8), p=0.09

CRP = C-reactive protein; eGFR = estimated glomerular filtration rate; PUJ = pelviureteric junction; VUJ = vesicoureteric junction; WCC = white cell count

form an important part of the management discussion with emergency patients before exposure to ionising radiation.

These data can aid clinicians in decision making and explaining management options to individuals with acute flank pain. The data can also be used to help those patients who have been labelled as having ureteric colic without radiological evidence of a calculus understand the wide range of differential diagnoses.

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