Clinical variables and stone detection in patients with flank pain

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Introduction: *Non-contrast CT (NCT) is commonly used to evaluate flank pain (FP). We sought to evaluate incidence of ureteral calculi on NCT in patients with FP, and to determine if clinical variables are associated with higher detection rates.*

Materials and methods: *Retrospective review identified 613 patients undergoing NCT for FP. Patient clinical data, NCT findings, and intervention were analyzed. Focus was placed on variables commonly associated with urolithiasis (V_{stone}), comprising hematuria, nausea/vomiting, and prior stone history. Statistical analysis was performed to identify risk of ureteral stones based on number and type of V_{stone}.*

Results: *No stone disease was identified on NCT in 175 patients (28.5%). NCT demonstrated 214 (35%), 72 (12%), and 152 (25%) patients with stones located in the kidney, ureter, or both, respectively. Only 33 (5%) patients had FP as their sole V_{stone}, with ureteral calculi identified in 6% of this cohort. The rate of ureteral calculi increased with more V_{stone}. Patients having all four V_{stone} were found to have the highest rate of ureteral stones (59%). Statistical analysis demonstrated a statistically significantly increased relative risk of stone formation given three or four V_{stone} when compared with FP alone.*

Conclusions: *Whereas isolated FP is associated with a lower rate of ureteral calculus detection, a significant increased relative risk of ureteral calculus is seen in patients with additional clinical variables associated with stone disease. Accordingly, it may be possible to improve detection rates of ureteral stones through the use of additional clinical variables to guide NCT selection.*

Key Words: urolithiasis, kidney stone, computerized tomography, cost of care

Introduction

Flank pain is a common reason for patient referral to the community urologist and is frequently evaluated with non-contrast computed tomography (NCT). The NCT has revolutionized the early detection and treatment of urolithiasis. Given the high sensitivity (> 95%) and high specificity (> 98%) of NCT, it has become a valuable tool for the diagnosis of patients with the symptoms of acute flank pain (AFP) and possible urinary calculi.[1-4] Smith et al first reported the value of NCT in the evaluation of acute flank pain in the emergency room setting.[5] Studies by Koroglu and Vieweg have shown that urolithiasis was the most frequent cause for AFP and credited NCT for its ability to identify urolithiasis as well as other causes of flank pain.[3,6] Additionally, the American College of Radiology's Appropriateness Criteria cite NCT as the most appropriate diagnostic exam for the evaluation of AFP.[7]

The speed and accuracy of modern CT scanners has led to a significant increase in the number of scans performed in the emergency room setting for acute flank pain.[8,9] While NCT does not use potentially harmful intravenous contrast agents, this modality

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does yield radiation exposure and impacts cost of care.[1-3,10] As such, methods that may increase specificity of NCT by clarifying indications for testing are beneficial. Prior study performed in the Emergency Department (ED) setting has revealed the incidence of ureteral calculi on NCT in patients with AFP to be approximately 34%.[5] Given potential differences between ED and outpatient settings, this study sought to examine the utilization of NCT for patients presenting with flank pain in a community urology practice. Moreover, we sought to determine if clinical variables could be used to aid in patient selection by increasing the likelihood of ureteral stone detection.

Materials and methods

A retrospective chart review of all patients undergoing NCT during a 7 month period (June 2010-January 2011) was performed. NCT were performed in the context of a large single-specialty urology practice comprised of 26 urologists. Study inclusion criteria consisted of a presenting complaint of flank pain. Upon study inclusion, comprehensive review was performed to identify additional patient demographics, presenting symptoms, laboratory assessment, NCT findings, and intervention performed. Specific focus was placed on variables (in addition to flank pain) commonly associated with urolithiasis (V_{stone}), comprising hematuria, nausea/vomiting, and prior stone history. Hematuria was defined as either a patient report of gross hematuria within the last 7 days, or > 3 red blood cells per high-powered field on microscopic examination.

NCT was performed utilizing a low-dose protocol on a Siemens Somatom AS 20 slice CT scanner. The protocol parameters were as follows: scan range (top of kidneys to the bladder base); slice thickness (3 mm); 130 Kilovolts; effective milliamperage 90; pitch 0.85. NCT scan interpretation was performed by one of two board certified radiologists. NCT radiology reports were reviewed to determine the presence of urinary calculi, calculus location, calculus number, presence of hydronephrosis, and to identify other abdominal/pelvic abnormalities.

Statistical analysis was performed to identify relative risk (RR) of ureteral stone identification based on number and type of $V_{stone.}$ All patients were considered to have 1 V_{stone} (flank pain). Accordingly, a maximum V_{stone} of 4 was possible, representing patients with flank pain, hematuria, nausea/vomiting, and prior stone history. Descriptive data are listed as mean (± standard deviation). A p value of < 0.05 was used to define statistical significance.

TABLE 1. **Non-contrast CT findings (n = 613)**

	Patients (%)
Stone location	
None	175 (28.5)
Renal	214 (34.9)
Ureteral	72 (11.8)
Renal and ureteral	152 (24.8)
Associated findings	
Hydronephrosis	143 (32.6)
Incidental findings	
Renal mass	5 (0.8)
Gynecologic pathology	14 (2.3)
Abdominal pathology	8 (1.3)
Skeletal pathology	3 (0.54)

Results

Chart review identified 859 patients undergoing NCT, with 613 (71.4%) presenting with a chief complaint of flank pain and being included in study analysis. The mean patient age was 49 years (+/- 0.6) years. The majority of patients were female (53%) and Caucasian (84%). The mean number of NCT ordered for patients presenting with flank pain during the study period per physician was 23.4 (range 4-55).

NCT findings are detailed in Table 1. A total of 175 patients (28.5%) had no evidence of stone disease on NCT. Of those patients with stones, 214 (34.9%), 72 (11.8%), and 152 (24.8%) patients had stones identified within the kidney, ureter, or both, respectively. One hundred and thirty-seven/224 (61%) patients with ureteral calculi (with or without renal calculi) had hydronephrosis. In contrast 6/214 (3%) of patients with isolated renal calculi had hydronephrosis. Five percent (n = 30) of all patients with flank pain had a non-stone finding on the NCT. More common non-stone findings included abdominal pathology (diverticulitis, hepatic lesions), skeletal pathology, gynecologic pathology (ovarian mass, fibroids), and renal mass. None of the patients required emergent medical management for non-stone findings on CT.

V_{stone} and related incidence of ureteral stone disease is detailed in Table 2. Only 33 (5%) patients had flank pain as their sole V_{stone}. In contrast, 33%, 44%, and 18% of patients had two, three, or four V_{stone}, respectively, comprising the majority of patients. Only 6% of patients with flank pain alone had a ureteral stone, in comparison with 59% of patients having all four V_{stone}. The percentage of patients with a ureteral stone

TABLE 2. **Incidence of ureteral stones based on V_{stone}**

	Patients (%)	Ureteral stone (%)	RR (p value)
Single symptom			
Flank/back pain	33 (5)	2 (6)	
2 V_{stone}*			
+NV	31 (5)	7 (23)	3.7 (0.08, 0.84-16.58)
+H	78 (13)	15 (19)	3.2 (0.11, 0.76-13.10)
+PS	95 (15)	23 (24)	4.0 (0.05, 1.00-16.03)
3 V_{stone}*			
+NV and PS	42 (7)	13 (31)	5.1 (0.02, 1.23-21.07)**
+H and NV	61 (10)	28 (46)	7.6 (< 0.01, 1.92-29.82)**
+H and PS	164 (27)	70 (43)	7.0 (< 0.01, 1.81-27.30)**
4 V_{stone}*			
+H and NV and PS	109 (18)	64 (59)	9.7 (0.001, 2.51-37.46)**

NV = nausea or vomiting; H = hematuria; PS = prior stone history
*including flank/back pain
**indicates statistical significance

increased in a linear fashion with increasing number of V_{stone}, Figure 1. Statistical analysis demonstrated a statistically significant increase in RR of stone formation given three or four V_{stone} when compared with flank pain alone, Table 2. In addition, there was an increased relative risk of stone formation with two $V_{stone.}$ However, these findings did not achieve statistical significance likely owing to sample size.

In contrast to ureteral calculi, the percentage of patients with isolated upper tract stones identified by NCT did not demonstrate a significant or linear increase with additional $V_{stone.}$ The incidence of isolated renal stones ranged from 1% to 12%, with the majority of V_{stone} analyses showing an incidence of isolated renal stones of 1%-5% (not shown).

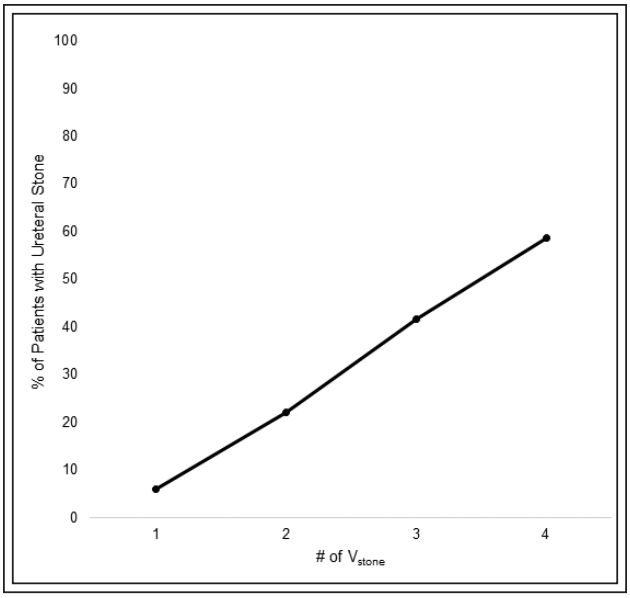

Figure 1. Incidence of ureteral stones based on V_{stone}.

Of the 224 patients diagnosed with ureteral stones, 71 underwent extracorporeal shock wave lithotripsy and 62 underwent ureteroscopy with laser fragmentation. Eighty patients passed the stone without surgical intervention and 10 were lost to follow up. Of the 6 patients with isolated renal calculi and hydronephrosis, no patients underwent acute intervention.

Discussion

Flank pain is a common reason for ED evaluation given the acute presentation. Investigation has demonstrated over 1 million ED visits for flank pain annually.[11] Similarly, outpatient urological evaluation of flank pain is common. Longitudinal study of outpatient utilization demonstrates over 2 million visits for a primary diagnosis of urolithiasis.[12] The role of NCT in the evaluation of flank pain is well established and is recommended as a diagnostic examination for the evaluation of flank pain.[7]

Although the likelihood of urolithiasis on NCT in ED patients with flank pain is well established,[5,6,8] there are potential differences between the ED and urology clinic settings that may affect outcomes. Foremost, patients presenting in the clinic setting may have less severe or acute pain in contrast to those that seek ED evaluation. We hypothesized that this possibility may increase the likelihood of non-urological etiologies

for pain (e.g. musculoskeletal). Second, given their familiarity with stones, we hypothesized that urologists may be more restrictive in ordering NCT thereby increasing rate of stone detection. For these reasons, we sought to confirm previous studies for acute flank pain in an ED setting.[5,6,8]

Our study reveals several important findings. First, the overall incidence of stone disease in this population was high. Almost 72% of patients imaged demonstrated urolithiasis. This is somewhat higher when compared to prior study performed in ED setting.[8] This finding may result from the geographic location of our practice, in which stone prevalence is high.[12] Further, the overwhelming majority of this patient population had additional clinical variables that are associated with stone disease.

Second, there was a significant incidence of ureteral stone identification. The 37% rate of ureteral calculi identification is also somewhat higher than in prior study.[6] The incidence of ureteral stones in the present study may reflect the nature of the patient population seen in a large urologic outpatient clinic. Accordingly, some patients with flank pain have been evaluated by their primary care physician prior to referral to the urologist. This may lead to a selection bias as patients with symptoms more consistent with other etiologies (e.g. musculoskeletal) may be treated and thus less likely to present for urological evaluation. In addition, given their experience with the evaluation of flank pain, urologists may be more discriminating in the decision to order NCT. These differences underscore the importance of evaluating ureteral stone detection rates in the outpatient setting.

Most importantly, the incidence of ureteral calculi increases as additional V_{stone} are present. Whereas patients with isolated flank pain demonstrated a relatively low incidence of ureteral calculi, the presence of all four V_{stone} was associated with a 59% incidence of ureteral stones. Similarly, a statistically significant increasing relative risk of ureteral calculi was noted given increasing number of $V_{stone.}$ These findings suggest that clinical variables may be used to aid in the decision to order NCT and counsel patients in the setting of AFP.

NCT represents a significant expenditure, with CT imaging for stone disease accounting for a significant portion of total expense per stone episode.[13] Further, imagining for renal colic represents a large part of total imaging performed by urologists.[14] Radiation exposure related to imaging for flank pain and urolithiasis is also a concern. Efforts to limit CT through low-dose renal colic CT and refining indications are reported.[15,16] By clarifying the indication for NCT for office patients presenting with flank pain, it may be possible to decrease the utilization of this test without compromising patient care. Despite the significant incidence of ureteral calculi in the present study, 63% of NCT failed to reveal a stone or found isolated renal calculi not highly consistent with the production of flank pain. While renal calculi can occasionally cause pain secondary to intermittent obstruction, the rare finding of hydronephrosis in patients with isolated renal calculi (3%) suggests that the vast majority of isolated renal calculi were likely asymptomatic. Combined, this data highlight that improved patient selection leading to higher test specificity is desired.

Our study suggests that it may be possible to improve detection rates of truly symptomatic ureteral stones through the use of additional clinical variables to guide NCT selection. In particular, our experience suggests that NCT in the setting of outpatient evaluation for isolated flank pain may be of relatively low yield. In comparison, the presence of additional V_{stone} may allow for increasing specificity of NCT. It is also possible that additional clinical or demographic variables may be used to further increase test specificity. For example, gender or race characteristics might be useful as these variables affect relative risk of urolithiasis in a general population. Importantly, these data also allow urologists to more specifically counsel patients on the likelihood of stone detection. As the decision to proceed with NCT is often based on informed discussion between physician and patient, these data might also help to limit NCT as patients might elect a period of observation given specific data about likelihood of ureteral stone identification.

Notably, significant non-urological incidental findings were infrequent in this population and none required emergent intervention. These findings suggest that, given a lower number of V_{stone} and/or clinical suspicion of obstructing calculus, a period of observation may be appropriate without significant risk of emergent non-urological findings.

Conclusion

In the outpatient urologic setting, ureteral calculi are identified in a significant percentage of patients with flank pain. Whereas isolated flank pain is associated with a lower rate of ureteral calculus detection, a statistically significant increased relative risk of ureteral calculus is seen in patients with additional clinical variables associated with stone disease. These data provide insight into ureteral detection rates in patients with flank pain and suggest that it may be possible to improve detection rates of truly symptomatic ureteral stones through the use of additional clinical variables to guide NCT selection.□

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