UTILITY OF HEMATURIA TESTING IN PATIENTS WITH SUSPECTED RENAL COLIC: CORRELATION WITH UNENHANCED HELICAL CT RESULTS

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ABSTRACT

Objectives. To determine the utility of hematuria testing in a large series of patients with suspected renal colic using unenhanced helical computed tomography (CT) as the reference standard.

Methods. A retrospective review of the CT reports of all patients who underwent unenhanced helical CT for suspected renal colic at one institution during a 3.5-year period and who also underwent a formal microscopic urinalysis within 24 hours of the CT study was conducted. The sensitivity, specificity, positive predictive value, and negative predictive value of the presence of any blood on the urinalysis for renal colic were calculated.

Results. Urolithiasis was present in 587 (62%) of the 950 patients, and 363 patients had negative examinations for renal colic, including 69 with significant alternative diagnoses in the latter group. Of the urinalyses, 492 were true-positive, 174 were true-negative, 189 were false-positive, and 95 were false-negative, yielding a sensitivity, specificity, positive predictive value, and negative predictive value of 84%, 48%, 72%, and 65%, respectively. Forty-six percent of the urinalysis results were negative for blood in the subset of patients with significant alternative diagnoses.

Conclusions. The sensitivity of hematuria on microscopic urinalysis for renal colic using unenhanced CT as the reference standard was 84%, and the specificity and negative predictive value was low. The presence or absence of blood on urinalysis cannot be used to reliably determine which patients actually have ureteral stones.

Renal colic is one of the most common suspected diagnoses evaluated in the emergency department, with an estimated lifetime incidence in the United States of 12%, and an annual cost estimated at 1.83 billion dollars.1–3 During the past few years, unenhanced helical computed tomography (UHCT) has steadily replaced intravenous urography (IVU) at many institutions as the imaging test of choice for suspected renal colic. The reasons for this are many, including the very high accuracy of UHCT and its ability to reveal alternative diagnoses.2,4,5

Prior studies have claimed a high sensitivity of hematuria testing in patients with suspected renal colic. These studies used IVU, stone collection, and other clinical outcomes as the reference standard for determining whether renal colic was actually present. The investigators of these studies have suggested that dipstick or microscopic urinalysis that is negative for blood can effectively exclude the diagnosis of an obstructing ureteral stone, and therefore additional testing and workup can be avoided.1,4

Because urinalysis is inexpensive, using it to triage patients before UHCT or other investigations would likely be cost-effective. However, the accuracy of hematuria testing in patients with suspected renal colic has recently been challenged.1 Three studies examined the accuracy of hematuria testing using the new, much more accurate, refer-
ence standard of UHCT and have also indicated that hematuria testing may be much less accurate than previously realized. \(^2,^3,^6\) However, all three series were relatively small, with total numbers of patients between 100 and 200. The purpose of our study, therefore, was to determine the utility of hematuria testing in a large series of patients with suspected renal colic, using UHCT as the reference standard.

**MATERIAL AND METHODS**

A retrospective review of the official reports of all UHCT examinations obtained at one institution for suspected renal colic during a 3.5-year period was performed. The presence or absence of a ureteral stone, or evidence of a passed ureteral stone, was recorded for each patient, along with the size of the ureteral stone. Cases positive for ureteral stone disease were placed into two categories: the first included ureteral stones 5 mm or smaller in the transverse diameter according to the official CT report results or evidence of a recently passed ureteral stone (typically some combination of renal swelling, hydronephrosis, hydrourerter, and perinephric and/or periureteric edema without a ureteral stone, and with or without a bladder calculus), and the second included ureteral stones larger than 5 mm in the transverse diameter. Alternative diagnoses were also recorded. Any follow-up CT examinations for the same episode of renal colic were not included.

The results of each official urinalysis examination performed in our hospital’s laboratory for the presence or absence and amount of blood in the urine were then obtained from the hospital’s main computer system and recorded if this test was obtained within a 24-hour period of the unenhanced CT study. The formal urinalysis included microscopic examination of the urine by a technologist. Our hospital records urinalysis results as trace (less than 10 RBC/mL), 1+/small (10 to 49 RBC/mL), 2+/moderate (50 to 249 RBC/mL), or 3+/large (more than 250 RBC/mL). Urine dipstick studies are generally not performed in our emergency department, as the formal microscopic urinalysis is the primary study used to examine urine specimens in our department, and therefore any dipstick studies were not evaluated. The sensitivity, specificity, positive predictive value, and negative predictive value of blood on the urinalysis for renal colic were then calculated for each patient who underwent both UHCT for suspected renal colic and the urinalysis within a 24-hour period. These were calculated using any blood on the urinalysis as a positive result, including trace blood (fewer than 10 RBC/mL urine), as well as with a higher threshold of 10 or more RBC/mL for a positive urinalysis result.

**RESULTS**

A total of 950 patients fulfilled the study’s entrance criteria. Of these, 587 (62%) had a ureteral stone or evidence of a recently passed ureteral stone, including 480 with a stone 5 mm or smaller (62 of whom had evidence of a recently passed ureteral stone) and 107 with a stone larger than 5 mm. In this group of 587 patients, 492 had positive urinalysis results (trace blood or greater) and 95 had completely negative urinalysis results for blood. The incidence of a completely negative urinalysis result for blood in patients with actual renal colic due to ureterolithiasis according to the unenhanced CT results was therefore 16%. Of the CT examinations, 363 (38%) were negative for a ureteral stone or recently passed stone, including 294 completely negative scans (31% of total) and 69 (7% of the total) that revealed a variety of significant alternative diagnoses (41 involving the genitourinary tract and 28 not related to the genitourinary tract—most commonly ovarian cysts [15 cases, 5 with a positive urinalysis result for blood], diverticulitis/colitis [13 cases, 6 with a positive urinalysis result], and pyelonephritis [6 cases, 4 with a positive urinalysis result]). Of this group of 363 patients, 189 had positive and 174 had negative urinalysis results.

The incidence of a negative urinalysis in patients with an alternative diagnosis was 46% (32 positive urinalysis results of 69 total). Therefore, there were 492 true-positive (52% of all cases), 174 true-negative (18%), 189 false-positive (20%), and 95 false-negative (10%) results using hematuria testing compared with the reference standard of UHCT for ureterolithiasis. The sensitivity, specificity, positive predictive value, and negative predictive value of blood on the urinalysis for renal colic was therefore 84%, 48%, 72%, and 65%, respectively.

Of the false-negative urinalysis findings, 83 occurred in patients with stones 5 mm or smaller (including 8 patients with evidence of a recently passed stone) and 12 were found in patients with stones larger than 5 mm. The incidence of a false-negative urinalysis finding in patients with renal colic was therefore 17% in patients with ureteral stones 5 mm or smaller and 11% in patients with stones larger than 5 mm.

The results were recalculated using the higher threshold for a positive urinalysis result as 10 or more RBC/mL urine. This produced 479 true-positive, 188 true-negative, 179 false-positive, and 113 false-negative results. The sensitivity, specificity, positive predictive value, and negative predictive value of 10 or more RBC/mL on the urinalysis for renal colic, using this more stringent threshold for a positive urinalysis result, was 81%, 51%, 73%, and 62%, respectively.

**COMMENT**

Renal colic is one of the most common diagnoses treated in the emergency department. \(^1\) The lifetime incidence of renal colic is estimated at 12% in the United States, and the estimated annual incidence of urolithiasis in the United States is 240 per 100,000 population. \(^2\) The annual cost of urolithiasis in the United States has been estimated at 1.83 billion dollars. \(^3\)

At most institutions and practices, UHCT has recently replaced IVU as the imaging test of choice.
for patients with suspected renal colic, for a variety of reasons. Compared with IVU, the advantages of UHCT include significantly increased speed of the examination, very high accuracy, improved stone sizing and localization (assisting in planning patient treatment), comparable or reduced radiation dose, and identification of significant alternative diagnoses.² ⁴ ⁵ ⁷ Prior investigations have claimed a high sensitivity for hematuria testing in patients with suspected ureteral stones and have suggested that negative urinalysis or urine dipstick results can be used to exclude the diagnosis of renal colic and preclude additional patient testing.¹ ⁴ ⁸ ⁹ Given the relatively inexpensive cost of urinalysis (eg, $40 at our institution) compared with UHCT (several hundred dollars), the use of urinalysis to triage patients before CT would likely be cost-effective. However, these prior investigations have used a combination of IVU results, stone collection, and clinical outcome as the reference standard for determining the presence or absence of renal colic.¹ ⁴ ⁸ ⁹

UHCT has been shown to be much more accurate for renal colic than other imaging examinations including IVU, sonography, and plain radiography, and therefore the accuracy of these earlier studies can be called into question.² ⁴

The accuracy of hematuria testing for diagnosing or excluding renal colic was first challenged in 1995 in a study by Press and Smith,³ although IVU was used as the reference standard for the presence or absence of ureterolithiasis. This retrospective review of 109 patients, using a cutoff of more than 1 RBC/high power field (HPF) for a positive urinalysis, revealed a 14.5% incidence of negative urinalysis results despite IVU findings that were positive for ureteral stones. However, the combination of negative urinalysis and negative urine dipstick findings reduced the incidence of false-negative urine studies to 5.5%.¹

In the first study, to our knowledge, to compare urinalysis with UHCT results, Miller et al.² reported that although 93% of 75 patients with ureterolithiasis did have more than 5 RBC/HPF, so did 61% of 31 patients without ureteral stones. In a recent study by Li et al.⁶ of 397 patients with proven ureterolithiasis, 9% with ureteral stones did not have hematuria, but only one half of the patients underwent UHCT. Bove et al.⁴ retrospectively compared the microscopic urinalysis and urine dipstick results with the UHCT results in 195 patients with suspected renal colic. Using CT as the reference standard, 30% of the 95 patients with ureteral stones had 1 or no RBC/HPF on urinalysis, and 51% of the 100 patients without ureteral stones had greater than 1 RBC/HPF. Of the patients with ureteral stones, 14% had both a negative dipstick result and either 1 or no RBC/HPF on urinalysis. Overall, with the definition of hematuria as greater than 1 RBC/HPF, the sensitivity of hematuria for ureterolithiasis was only 81%, similar to the 84% obtained in our current series.⁹

Ours is the largest series to date to address the role of hematuria testing in patients with suspected renal colic using unenhanced helical CT as the reference standard. Our results support the conclusion of Bove et al.⁴ that hematuria testing cannot be used to exclude the diagnosis of ureterolithiasis and should not preclude additional diagnostic testing. The urinalysis results of our series were only 48% specific for renal colic, the negative predictive value was only 65%, and only 54% of the 69 patients with a significant alternative diagnosis had a positive urinalysis for hematuria. Fifty-two percent of the 363 patients who proved to not have renal colic on the basis of UHCT had some blood in the urinalysis. Although a false-negative urinalysis result was more slightly likely in patients with a stone 5 mm or smaller (17% false-negative incidence in the 480 such patients) compared with patients with a stone larger than 5 mm (11% false-negative incidence in the 107 such patients), the stone size is not known until a CT scan is performed. Hematuria testing is therefore not a very accurate method for diagnosing or excluding renal colic, but in those patients who are subsequently shown to have ureterolithiasis, urinalysis may then be indicated for other reasons (ie, pH or crystalline analysis).

There are some potential limitations of our study. We did not examine the urine dipstick results from the emergency department, as they were not on our hospital’s computer system. However, at our institution a formal urinalysis is strongly preferred to a urine dipstick test. Some authorities have suggested that dipstick analysis performed immediately after urine collection may decrease the false-negative rate of hematuria testing,¹ but 14% of the patients with ureteral stones in the study of Bove et al.⁴ had both negative urinalysis and negative urine dipstick results. Our study was retrospective, and we could not determine why a minority of patients who underwent CT but not formal urinalysis (approximately an additional 140 patients who were excluded from our study) did not undergo both tests. Also, there were likely some additional patients seen in the emergency department during the study period with suspected renal colic who did not undergo CT, and it is possible that a small number of patients may have not undergone CT scans once completely negative urinalysis results were obtained.

However, the likelihood that there were significant biases as a result of either of these scenarios is relatively small, since at our institution almost all patients who present to the emergency department
with acute abdominal and pelvic pain undergo a cross-sectional imaging study, especially a CT scan. A prospective study, in which every patient with a clinical suspicion of renal colic underwent both UHCT and urinalysis, would avert any of these potential biases. A final potential limitation is that different institutions have used different criteria for labeling a urinalysis result as negative or positive for hematuria, and the methods for measuring hematuria are not necessarily precise; we, therefore, calculated our results with two different thresholds, but no major differences resulted.

CONCLUSIONS

In our series of almost 1000 patients who underwent both urinalysis and UHCT, although the sensitivity of a formal microscopic urinalysis for the diagnosis of ureterolithiasis was somewhat high (84%), the specificity (48%) and negative predictive value (65%) of urinalysis were low, and approximately 50% of patients with significant alternative diagnoses had a negative urinalysis. Although every patient with suspected renal colic does not necessarily require UHCT, the presence or absence of hematuria on urinalysis cannot be used to diagnose or exclude ureterolithiasis with a high degree of accuracy and should not be used to decide which patients should or should not undergo UHCT.

REFERENCES