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# Diagnostic utility of microhematuria in renal colic patients in emergency medicine: correlation with findings from multidetector computed tomography

**Murat Das[1], Okan Bardakci[1], Ersan Yurtseven[1], Canan Akman[1], Yavuz Beyazit[2], Okhan Akdur[1]**

*[1]Canakkale Onsekiz Mart Universty, Faculty of Medicine, Department of Emergency Medicine, Canakkale, Turkey*
*[2]Canakkale Onsekiz Mart Universty, Department of Internal Medicine, Canakkale, Turkey*

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**Abstract**
Although urine analysis is a simple and inexpensive method for the initial evaluation of renal colic patients presenting in emergency departments, it is regarded as unreliable for an exact diagnosis of urinary system stones. The aim of the present study is to assess the association between clinical demographics, and stone size and location, with the combined utility of urinalysis and unenhanced multidetector computed tomography (MDCT) in the emergency department. After gaining local Ethics Committee approval, a retrospective study was conducted with data from 186 patients who presented at our emergency service with flank pain and documented urolithiasis. Stone location and size was determined by MDCT, and the presence of microhematuria confirmed by urinalysis. The presence of hydronephrosis and clinical complaints were also recorded. A total of 186 patients were included in the present study, in which an absence of microhematuria was recorded in 24.7% patients. Urine density was found to be elevated in the microhematuria group (p=0.001). Upper urinary tract stones and hydronephrosis were found to be associated with the presence of microhematuria. Although statistically insignificant, an increased trend of microhematuria was observed with stones over 5 mm in size. Urinary stone size and location are directly associated with the incidence of microhematuria. Absence of microhematuria does not preclude MDCT imaging, however, especially in cases where stones are suspected in patients with renal colic.

**Keywords:** Unenhanced MDCT, renal colic, emergency department

## Introduction

Urinary stones are globally one of the most common medical problems to have increased in prevalence over the past three decades [1]. The reported lifetime prevalence of urinary stones varies between 10 and 20% of the population, with a relapse rate of 50% within 5–10 years, and 75% within 20 years [2,3]. This worldwide trend has been demonstrated by studies conducted in Turkey [4,5] and elsewhere.

Urolithiasis is the most commonly encountered cause of flank pain in emergency medical settings [6,7]. Although a diagnosis of urolithiasis is generally based on the history, clinical symptoms, and physical exam¬ination of the patient, an additional diagnostic work-up is usually required to reach a definitive conclusion. In this context, microhematuria as determined by urinalysis can be regarded as a simple, easy to apply, and inexpensive diagnostic tool for urolithiasis, but one involving several disadvantages, among them constraints and unreliability. Unfortunately, the absence of microhematuria does not always exclude the possibility of urinary stones, and nearly 10% of patients with urinary lithiasis have negative urinary testing on initial admission to emergency clinics [8].

Unenhanced multidetector computed tomography (MDCT) is a universally accepted gold standard diagnostic method for detecting urolithiasis [9]. At our institution, all patients who presented to the emergency service with flank pain and suspicion of a urinary stone are routinely evaluated with a computed tomography (CT) scan. The main advantage of CT scanning over intravenous urography and urinary system ultrasound is its superior accuracy for definitive detection of urolithiasis and the ruling out of alternative diagnoses that could account for the patient's clinical presentation [10,11].

Considering the important role of emergency departments in the diagnosis and management of renal colic patients, the value of clinical, laboratory, and imaging data from emergency clinics has

***Coresponding Author:** Murat Das, Canakkale Onsekiz Mart Universty, Faculty of Medicine, Department of Emergency Medicine, Canakkale, Turkey
E-mail: muratdas58@gmail.com

been under-studied in Turkey. Therefore, the objective of the present study is to evaluate distinct variables, including demographics, admission symptoms, laboratory results, and imaging findings in symptomatic renal colic patients with the presence of urinary stones confirmed by MDCT.

## Material and Methods

### Subjects

This study is undertaken after the approval from local institutional ethics board. We have performed a retrospective analysis of 1027 patients who were admitted to the emergency department of Canakkale Onsekiz Mart University Hospital between January 2016 and December 2017 with flank colic pain. Out of these 1027 patients, only 518 was found to receive an unenhanced MDCT scan because of suspicion of an urinary stone. From 518 patients, we have excluded 332 patients due to lack of complete blood cell counts, biochemical evaluations or urinanalysis. In overall, 186 patients were included in the final analyses.

### Study design

Demographic characteristics, urinalysis results, the presence of hydronephrosis, clinical complaints, alternative diagnoses, and the presence or absence of urolithiasis as revealed by MDCT, were recorded for each patient. The number and the size of the stones were also recorded for further analysis. Patients with a history of renal/ureteral operations with or without use of ureteric stents were excluded. Moreover, a history of lithotripsy was also considered an exclusion criterion.

Urinalysis included microscopic examination of urine within 2h of emergency admission. Patients were classified by the status of red blood cells on urinalysis in two groups: those with five or fewer erythrocytes per high power field were taken as the absence-of-hematuria group (Group I); those with more than five red blood cells per high-power field were regarded as the microhematuria group (Group II).

All multi-detector CT scanner (Toshiba® Asteion TSX-021B) images were obtained without oral or intravenous contrast. Scans were obtained which covered the entire urinary tract (from the upper borders of the kidneys to the lower aspect of the symphysis pubis) with a narrow collimation of 1 mm and the remainder with 3 mm sections. The size and location of each calculus was determined using information from the radiology report. Stone size was categorized as either ≤5mm or >5mm (with a cutoff representing median stone size). The location of the stones was categorized either as 'lower' (below two-thirds of the distal portion of the ureter) or 'upper'.

### Statistical analyses

The data were analyzed with SPSS 20.0 software. Numbers, percentages, means, and standard deviations were used in the presentation of values. The Mann Whitney U test was applied as the non-parametric test when the data was not normally distributed. The Chi square test was applied for categorical data analysis. When the p value was under 0.05, the result was regarded as statistically significant.

## Results

During the enrollment period, a total of 1027 patients were admitted to our tertiary referral center complaining of renal colic. Of these, 518 underwent unenhanced MDCT. Of this number, 332 patients were excluded from the present study due to lack of complete blood cell counts, biochemical evaluations, or urinalysis. In total, therefore, the study population consisted of 186 patients with a mean age of 44.8±16.1 years, comprising 57 (30.6%) females and 129 (69.4%) males. Figure 1 presents a flow diagram of the study. According to the urinalysis, 140 (75.3) patients had microhematuria, and 46 (24.7%) patients had no microhematuria. The demographic and laboratory characteristics of the patients are presented in Table 1. Only urine density was found to be significant in both groups (p=0.001).

**Table 1.** Demographic, clinical, and laboratory characteristics of study population

| | Group I (Without Hematuria) | Group II (With Hematuria) | p |
|---|---|---|---|
| | Mean±SD | Mean±SD | |
| **Age (years)** | 48.5±17.0 | 43.6±15.7 | 0.067 |
| **Urine density** | 1014.6±7.2 | 1018.1±5.7 | 0.001 |
| **Urea (mg/dL)** | 31.8±9.8 | 34.2±11.4 | 0.275 |
| **Creatinine (mg/dL)** | 0.9±0.3 | 1.0±0.6 | 0.416 |
| **ALT (U/L)** | 23.7±25.8 | 22.2±15.9 | 0.455 |
| **AST (U/L)** | 23.8±16.7 | 20.4±8.4 | 0.516 |
| **Sodium (mmol/L)** | 140.2±2.7 | 140.2±3.4 | 0.759 |
| **Chloride (mmol/L)** | 100.8±3.2 | 100.6±3.9 | 0.832 |
| **Potassium (mmol/L)** | 4.3±0.4 | 4.2±0.4 | 0.194 |
| **Calculi size (mm)** | 4.4±2.9 | 4.5±3.4 | 0.527 |

SD: Standard deviation, p: Mann Whitney U Test
ALT: Alanine amino transferase, AST: Aspartate amino transferase

Patients were classified according to their presenting symptoms, the most common of which was flank, inguinal, and supra-pubic pain. Statistical analysis revealed no significant difference between the two groups in terms of presenting symptoms (Table 2). Groups were also evaluated according to hydronephrosis. The presence of hydronephrosis between Group I and Group II was statistically significant (p=0.001). Microhematuria patients were found to be more likely to present with hydronephrosis (Table 3).

From assessment of unenhanced MDCT results, urinary tract stones were evaluated as having either a 'lower' or 'upper' urinary tract location. The patients in the absence-of-hematuria group were more likely to have a lower stone location (76.1% vs. 23.9%, p=0.006). The incidence of microhematuria seemed to increase in patients with stones over 5 mm in size; however, the correlation between the size of the stone and microhematuria was insignificant (Table 3).

**Table 2.** Pain localization with accompanying clinical characteristics related to hematuria status

| | Group I (Without Hematuria) n(%) | Group II (With Hematuria) n(%) | p |
|---|---|---|---|
| **Number of Patients** | 46 (24.7) | 140 (75.3) | |
| **Sex** | | | |
| **Female** | 19 (33.3) | 38 (66.7) | 0.105 |
| **Male** | 27 (20.9) | 102 (79.1) | |
| **Pain localization** | | | |
| **Flank pain** | 39 (24.4) | 121 (75,6) | |
| **Inguinal pain** | 3 (21.4) | 11 (78,6) | |
| **Supra-pubic pain** | 1 (33.3) | 2 (66,7) | |
| **Other pain** | 3 (33.3) | 6 (66,7) | |
| **Drug use** | 11(24.6) | 34 (75.4) | 1.000 |
| **Chronic illness** | 1(33.3) | 2(66.7) | 1.000 |
| **n: Number, %: Row Percentage, p: Chi square test** | | | |

**Table 3.** Correlations between stone size, position of stone, and hydronephrosis in the two study groups.

| | Group I (Without Hematuria) n(%) | Group II (With Hematuria) n(%) | p |
|---|---|---|---|
| **Hydronephrosis** | | | |
| **No** | 22 (47.8) | 29 (20.7) | 0.001 |
| **Yes** | 24 (52.2) | 111(79.3) | |
| **Stone localization** | | | |
| **Lower urinary tract** | 35 (76.1) | 74 (52.9) | 0.006 |
| **Upper urinary tract** | 11 (23.9) | 66 (47.1) | |
| **Stone size** | | | |
| **≤5 mm** | 37 (80.4) | 99 (70.7) | 0.197 |
| **>5 mm** | 9 (19.6) | 41 (29.3) | |
| **n: Number, %: Column Percentage, p: Chi square test** | | | |

## Discussion

This single-center retrospective study has revealed that a lower urine density and lower urinary stone location are both associated with the absence of hematuria in patients presenting with urinary system stone disease. Moreover, renal complications such as hydronephrosis were found to be significantly related to the presence of hematuria.

Renal colic is one of the most frequently encountered issues treated in emergency departments globally [12]. Although the reported lifetime incidence varies across different populations, the estimated annual incidence of urolithiasis is 240 per 100,000 of the population in the United States [13]. Urolithiasis is also a severe problem in Turkey, with high prevalence and incidence rates. In a recent study by Muslumanoglu et al. [4], the prevalence rate of urolithiasis in Turkey was reported to increase gradually with age in both men and women, varying from 8% in the younger group (<25 years) to 26.6% in the 45-to-55 year group. Authors have concluded that 11.1% of the population have a history of urinary stone disease, as diagnosed by a physician, and an additional 2.1% have had at least one episode of renal colic. These patients have elevated rates of emergency medical admission.

As a further point, it is important to note that clinicians need to obtain diagnostic certainty prior to initiating optimal treatment. For this reason, simple and effective diagnostic tools are essential in the emergency setting. Our results demonstrate the importance of CT scanning in the diagnosis of renal colic, even in the absence of microhematuria. Although it is not suggested here that every

physician should perform a non-contrast CT scan in order to diagnose a urinary tract stone, the importance of CT scanning in order to diagnose urolithiasis cannot be exaggerated. Low-dose unenhanced CT (UHCT) visualization is considered a state-of-the-art method for diagnosing urinary stones [14]. As with most comparable institutions and practices, our center has in recent years replaced intravenous urography with UHCT as the primary diagnostic modality. The main underlying reason for this shift is the superior ability of CT scanning in the detection of urinary stones, regardless of size, location, and composition, with a sensitivity and specificity exceeding >95% [15,16]. Moreover, non-contrast CT scanning avoids the risk of contrast reactions and is able to diagnose other disease conditions that can cause flank pain. However, it should be noted that non-contrast CT scanning can underestimate ureteral stone size by up to 12% [17].

In the present study, we define microscopic hematuria as a detection of more than five red blood cells per high-power field in the urinalysis. It is important to determine the presence of hematuria in urinalysis, in the diagnostic workup of cases of suspected renal colic; however, the sensitivity of microhematuria presence in this patient group can vary between 69% and 84% [18,19]. Nevertheless, it is considered here that a simple urinalysis is practical on account of its reproducibility, rapidity, low cost, and widespread availability in almost all emergency departments. The results of the present study do reveal, however, that the absence of hematuria does not exclude a diagnosis of urolithiasis – nor does it help indicate the exact location of a urinary stone. Moreover, it should be noted that the presence of a lower urinary tract stone in renal colic patients seems to go hand-in-hand with a higher incidence of the absence of hematuria.

Elevated rates of hydronephrosis constitute another complication that this study detected in renal colic patients with hematuria. This is understandable in that the presence of increased size of urinary stones in this patient group can easily lead to the complication of hydronephrosis. Contrary to these findings, however, are those of Mefford et al. [18]. These researchers proposed that microscopic hematuria is less sensitive in detecting urolithiasis in patients with obstructive uropathy. Though unable to provide an exact rationale for this finding, they did propose that larger ureteral stones may obstruct bleeding, resulting in the absence of hematuria on urinalysis.

In the present study, it was also demonstrated that the size of the stones (measured in mm) is correlated with the presence of microhematuria. In agreement with the current study, Lallas et al. [20] demonstrated that stones ≥8mm were more than twice as likely to be associated with microhematuria. In another study, Argyropoulos et al. [21] demonstrated the efficacy of a stone size cut-off point of 6 mm in determining microhematuria through use of a urine dipstick test. Thus, the results of the current study can be seen to be in agreement with the literature. It is also noteworthy that stone size and location were seen to be correlated with the hallmark signs of urolithiasis, including renal colic, urinary urgency, fever, and hematuria [22]. The location of the stone is also associated with patient symptoms such as pain in the flank, inguinal, and supra-pubic areas. Elton and colleagues [23] found that unilateral flank pain was a predominating symptom in 89% of 206 emergency department patients with a diagnosis of ureteral calculus. Interestingly, Lallas et al. [20] reported in their study that urinary stones located in the renal calyces were the least symptomatic (16.9%) when compared to those situated in the renal pelvis (58.8%) or ureter (82.4%). In contrast, in the present study no symptomatic differences were observed between the patient groups. This might have been due to our relatively small patient groups and the retrospective nature of the study.

The results of the present study should be carefully evaluated in the context of several limitations. First, retrospective nature of the study may lead to selection bias and statistical underpowering. Second, although this is study is one of the largest study in literature exploring the urinary stone patients with no absent hematuria, it is obvious that a large sample size should increase the value of the study. Finally, it must be noted that different centers have used different criterias for labeling a urinalysis result as negative or positive for hematuria, and the methods for measuring hematuria are not precise.

## Conclusion

In conclusion, the presence of microhematuria can vary depending on the size and location of the urinary stone. In addition, it is suggested that non-contrast CT should be applied in all suitable cases, even in the absence of microhematuria.

**Competing interests**
*The authors declare that they have no competing interest*

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**Ethical approval**
*Ethics committee decision number: 2011-KAEK-27/2018-E.1800154812 receives approval from the ethics committee.*

*Murat Das ORCID: 0000-0003-0893-6084*
*Okan Bardakci ORCID: 0000-0001-6829-7435*
*Ersan Yurtseven ORCID: 0000-0003-0469-5260*
*Canan Akman ORCID: 0000-0002-3427-5649*
*Yavuz Beyazit ORCID: 0000-0001-6247-2714*
*Okhan Akdur ORCID: 0000-0003-3099-6876*

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