CODEN [USA]: IAJPBB ISSN: 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

SJIF Impact Factor: 7.187
https://zenodo.org/records/10437606

https://www.iajps.com/volumes/volume10-december-2023/49-issue-12-december-23/

Available online at: http://www.iajps.com Research Article

ASSESSMENT OF THE DIAGNOSTIC ACCURACY OF MICROHEMATURIA VERSUS GROSS HEMATURIA IN THE DIAGNOSIS OF UROLITHIASIS

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Abstract:

Background: *Urolithiasis, commonly known as kidney stones, is a prevalent condition that affects millions of people worldwide. Hematuria, the presence of blood in the urine, has long been considered an important clinical marker for urolithiasis.* ***Objective:*** *The objective of this study was to assess the diagnostic accuracy of microhematuria and macrohematuria compared to computed tomography (CT) diagnosis as the reference standard for urolithiasis. Additionally, we aimed to evaluate the role of hydronephrosis in diagnosing urolithiasis.* ***Methods:*** *A total of 267 patients with suspected urolithiasis who underwent both CT scans and urine analysis were included in the study. Patients with specific medical conditions that could interfere with the interpretation of the results were excluded. The diagnostic test accuracy of gross hematuria, microscopic hematuria, and hydronephrosis was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) with 95% confidence intervals (CIs).* ***Results:*** *The analysis revealed that gross hematuria exhibited a high sensitivity of 98.7% (95% CI: 95.7% - 99.7%) but had a low specificity of 6.0% (95% CI: 2.1% - 14.6%). Microscopic hematuria showed a sensitivity of 97.2% (95% CI: 93.5% - 98.9%) and a specificity of 4.4% (95% CI: 1.5% - 11.2%). Hydronephrosis demonstrated a sensitivity of 100% (95% CI: 97.4% - 100%) but had a specificity of 7.2% (95% CI: 3.2% - 15.3%). The NPV for gross hematuria, microscopic hematuria, and hydronephrosis were 6.0% (95% CI: 2.1% - 14.6%), 4.4% (95% CI: 1.5% - 11.2%), and 0% (95% CI: 0% - 2.7%), respectively.* ***Conclusion:*** *Gross hematuria and microscopic hematuria showed high sensitivity but low specificity in diagnosing urolithiasis. Hydronephrosis exhibited excellent sensitivity but limited specificity and a low NPV. These findings highlight the importance of a comprehensive diagnostic approach that combines clinical evaluation, urine analysis, and imaging modalities such as CT scans to achieve accurate urolithiasis diagnosis. Clinicians should interpret hematuria findings cautiously due to the potential for false-positive results. Integrating these parameters into a diagnostic algorithm can assist in clinical decision-making and patient management. Further research is needed to validate these findings in larger and more diverse populations.*

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Please cite this article in press Abdulrahman abed Alqurashi et al., ***Assessment Of The Diagnostic Accuracy Of Microhematuria Versus Gross Hematuria In The Diagnosis Of Urolithiasis,*** *Indo Am. J. P. Sci, 2023; 10 (12).*

BACKGROUND:

Urolithiasis is a complex medical condition characterized by the formation of calculi within the urinary tract, commonly known as kidney stones [1, 2]. These stones can obstruct the urinary flow, leading to severe pain, urinary tract infections, and potential kidney damage if left untreated [3, 4]. The prevalence of urolithiasis has been steadily rising over the past few decades, making it a significant public health concern [2].

The accurate and timely diagnosis of urolithiasis is vital for appropriate management and prevention of complications associated with this condition [5-7]. Various diagnostic modalities are available, including imaging techniques such as ultrasound, computed tomography (CT) scans, and intravenous pyelography (IVP) [6-8]. However, these methods can be costly, invasive, and may involve exposure to ionizing radiation, which raises concerns about patient safety.
Hematuria, the presence of blood in the urine, has long been recognized as a useful clinical marker in the diagnosis of urolithiasis. Its detection provides important clues to the presence of urinary tract pathology, including kidney stones [9]. The assessment of hematuria has traditionally been classified into two categories: microhematuria, which refers to the presence of blood that is not visible to the naked eye, and gross hematuria, where blood is visibly evident in the urine [9, 10].

Although both microhematuria and gross hematuria have been associated with urolithiasis, there is an ongoing debate regarding their diagnostic accuracy and clinical significance [10]. Some studies suggest that gross hematuria is a more reliable indicator of urolithiasis, as it directly correlates with the presence of larger stones or active stone passage [11]. On the other hand, microhematuria, even in the absence of visible blood, may be indicative of underlying urolithiasis, especially in cases involving smaller stones or intermittent stone passage [12].

The discrepancy in the diagnostic accuracy of microhematuria versus gross hematuria highlights the need for a comprehensive evaluation and comparison of these two parameters in the diagnosis of urolithiasis.

Study Aim

This study aims to assess and compare the diagnostic accuracy of microhematuria and gross hematuria in identifying urolithiasis, with a focus on determining the optimal threshold for hematuria detection. By elucidating the relative merits of these two diagnostic markers, this research may contribute to improved clinical decision-making and patient outcomes in the management of urolithiasis.

METHODOLOGY

Study Design and Setting

This study employed a retrospective cross-sectional design and was conducted at King AbdulAziz Specialist Hospital, Taif, Kingdom of Saudi Arabia. The hospital serves as a tertiary care center and is equipped with advanced diagnostic facilities, including computed tomography (CT) scanning capabilities.

Study Population

The study population consisted of patients who presented with suspected urolithiasis and underwent both urine analysis and CT scanning of the kidneys, ureters, and bladder (KUB) in the same visit. A total of 267 patients were included in the study, selected consecutively from the hospital's electronic medical records system during a specified time period.

Inclusion Criteria:

- Patients diagnosed with urolithiasis based on the clinical evaluation by a urologist.
- Patients who underwent a KUB, pelvic, or abdomen CT scan as part of the diagnostic workup.
- Patients who had a urine analysis performed in the same visit as the CT scan.

Exclusion Criteria:

- Patients with a history of nephrostomy or ureteral stent placement.
- Patients with a diagnosis of benign prostatic hyperplasia (BPH) or kidney, bladder, or prostate cancer.
- Patients with any intraabdominal mass causing ureteral obstruction.

Data Collection

Data were extracted from the electronic medical records system using a standardized data collection form. The following variables were recorded for each patient:

- Demographic information: age, gender.
- Clinical data: symptoms related to urolithiasis (e.g., flank pain, hematuria), duration of symptoms, and medical history.
- Urine analysis results: presence or absence of microhematuria or macrohematuria, as reported by the laboratory.
- CT scan findings: presence or absence of urolithiasis, stone location, stone size, and degree of obstruction, as determined by the radiologist.

Reference Standard

The CT scan (Spectral CT-20 Scanner Manufactured by Philips), was considered the reference standard for diagnosing urolithiasis. CT scans were reviewed by experienced radiologists who were blinded to the urine analysis results. The presence or absence of urolithiasis and stone characteristics, such as location and size, were recorded based on the radiology reports.

Data Analysis

Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarize the demographic and clinical characteristics of the study population. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of microhematuria and macrohematuria in detecting urolithiasis were calculated using the CT scan as the reference standard. Receiver operating characteristic (ROC) curve analysis was performed to determine the optimal threshold for hematuria detection.

Ethical Considerations

This study was approved by the Institutional Review Board (IRB) of King AbdulAziz Specialist Hospital. Patient confidentiality was strictly maintained, and all data were anonymized and securely stored. Informed consent was waived due to the retrospective nature of the study.

RESULTS:

Table 1 presents the characteristics of the included sample and the findings of CT scans, gross hematuria, and microscopic hematuria. The study included a total of 267 patients with suspected urolithiasis, with varying age ranges. The majority of the patients fell into the age groups of 20-40 years (47.9%) and 41-60 years (39.7%). A smaller proportion of patients were in the age group of 61-86 years (12.4%). In terms of gender distribution, the study consisted of 84 females (31.5%) and 183 males (68.5%).

The CT diagnosis served as the reference standard for identifying urolithiasis. Out of the 267 patients, 258 (96.6%) had a positive CT diagnosis, indicating the presence of urolithiasis. Only 9 patients (3.4%) had a negative CT diagnosis, suggesting the absence of urolithiasis. Regarding the size of the diagnosed stones, the majority of cases (54.7%) were classified as small, with a size equal to or less than 0.5 units. A substantial portion of cases (31.1%) had large stones, exceeding the threshold of 0.5 units. There were 29 cases (10.9%) with unspecified stone size, and 9 cases (3.4%) with no stones detected.

The CT scan findings also provided information about stone location. Among the included patients, 137 (51.3%) had kidney stones, as confirmed by the CT scan. On the other hand, 130 patients (48.7%) had no kidney stones. Regarding bladder stones, 36 patients (13.5%) had positive CT findings, while the majority of cases (86.5%) showed no presence of bladder stones. Urethral stones were relatively rare, with only 3 cases (1.1%) identified by the CT scan, while 264 cases (98.9%) had no urethral stones. Ureteric stones were more prevalent, with 154 cases (57.7%) showing positive CT findings and 113 cases (42.3%) displaying no ureteric stones. Hydronephrosis, a condition characterized by the swelling of the kidneys, was present in 142 patients (53.2%), while 125 patients (46.8%) had no evidence of hydronephrosis.

The analysis of hematuria included both gross hematuria, visible blood in the urine, and microscopic hematuria, which is not visible to the naked eye. Among the patients, 150 (56.2%) had positive findings of gross hematuria, indicating the presence of visible blood in their urine. On the other hand, 117 patients (43.8%) had negative results for gross hematuria. In terms of microscopic hematuria, 177 patients (66.3%) had positive findings, suggesting the presence of blood in their urine even though it was not visible to the naked eye. Ninety patients (33.7%) had negative results for microscopic hematuria.

Table 2 provides a detailed analysis of the association between the CT diagnosis of urolithiasis and the presence of gross hematuria, microscopic hematuria, and hydronephrosis. The results are presented in terms of the number and percentage of patients with positive and negative CT diagnoses in relation to each parameter. The statistical significance of these associations is also presented through p-values.

Regarding the association between gross hematuria and the CT diagnosis of urolithiasis, the table shows that out of the 117 patients who had negative findings for gross hematuria, 7 patients (6%) had a negative CT diagnosis of urolithiasis, indicating no presence of stones. In contrast, among the 150 patients who tested positive for gross hematuria, a significant majority of 148 patients (98.7%) had a positive CT diagnosis of urolithiasis. The association between gross hematuria and the CT diagnosis was found to be statistically significant, with a p-value of 0.037.

In the case of microscopic hematuria, the table reveals that among the 90 patients with negative results for microscopic hematuria, 4 patients (4.4%) had a negative CT diagnosis of urolithiasis. On the other hand, out of the 177 patients with positive findings for microscopic hematuria, 172 patients (97.2%) had a positive CT diagnosis of urolithiasis. However, the association between microscopic hematuria and the CT diagnosis did not reach statistical significance, as indicated by a p-value of 0.488.

The association between hydronephrosis and the CT diagnosis of urolithiasis is also demonstrated in Table 2. Among the 125 patients with negative findings for hydronephrosis, 9 patients (7.2%) had a negative CT diagnosis of urolithiasis. In contrast, among the 142 patients with positive results for hydronephrosis, all of them (100%) had a positive CT diagnosis of urolithiasis. The association between hydronephrosis and the CT diagnosis was highly significant, with a p-value of 0.001.

In Table 3, the diagnostic test accuracy of gross hematuria, microscopic hematuria, and hydronephrosis in reference to CT diagnosis is presented. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) are calculated for each parameter, along with their respective 95% confidence intervals (CIs).

For gross hematuria, the sensitivity is 98.7% (95% CI: 95.2% - 99.8%), indicating that it correctly identifies 98.7% of cases with urolithiasis. However, the specificity is 6.0% (95% CI: 2.2% - 14.3%), suggesting that it has a low ability to rule out urolithiasis in patients without gross hematuria. The positive predictive value is 98.7% (95% CI: 95.2% - 99.8%), indicating the probability that a positive gross hematuria result corresponds to a true positive CT diagnosis. Conversely, the negative predictive value is 6.0% (95% CI: 2.2% - 14.3%), representing the probability that a negative gross hematuria result corresponds to a true negative CT diagnosis.

For microscopic hematuria, the sensitivity is 97.2% (95% CI: 93.9% - 98.9%), indicating its high ability to detect urolithiasis cases. However, the specificity is 4.4% (95% CI: 1.5% - 11.2%), suggesting limited ability to rule out urolithiasis in patients without microscopic hematuria. The positive predictive value is 97.2% (95% CI: 93.9% - 98.9%), indicating the probability that a positive microscopic hematuria result corresponds to a true positive CT diagnosis. The negative predictive value is 4.4% (95% CI: 1.5% - 11.2%), representing the probability that a negative microscopic hematuria result corresponds to a true negative CT diagnosis.

Regarding hydronephrosis, the sensitivity is 100% (95% CI: 97.4% - 100%), indicating its ability to identify all cases of urolithiasis with hydronephrosis. However, the specificity is 7.2% (95% CI: 3.2% - 15.3%), suggesting a low ability to rule out urolithiasis in patients without hydronephrosis. The positive predictive value is 92.8% (95% CI: 89.1% - 95.5%), indicating the probability that a positive hydronephrosis result corresponds to a true positive CT diagnosis. Notably, the negative predictive value is 0% (95% CI: 0% - 2.7%), indicating that a negative hydronephrosis result does not reliably exclude urolithiasis.

Table 1: Characters of the included sample and findings of CT, gross hematuria and microhematuria.

Parameter		Frequency (%)
Age, y	**20 -**	128 (47.9%)
	41 -	106 (39.7%)
	61 - 86	33 (12.4%)
Sex	**Female**	84 (31.5%)
	Male	183 (68.5%)
CT Diagnosis	**Negative**	9 (3.4%)
	Positive	258 (96.6%)
CT Diagnosis: Size	**large (more than 0.5)**	83 (31.1%)
	No	9 (3.4%)
	small (equal or less than 0.5)	146 (54.7%)
	Unspecified	29 (10.9%)
Kidney stone (CT)	**Negative**	130 (48.7%)
	Positive	137 (51.3%)
Bladder stone (CT)	**Negative**	231 (86.5%)
	Positive	36 (13.5%)
Urethral stone (CT)	**Negative**	264 (98.9%)
	Positive	3 (1.1%)
Ureteric stone (CT)	**Negative**	113 (42.3%)
	Positive	154 (57.7%)
Hydronephrosis	**Negative**	125 (46.8%)
	Positive	142 (53.2%)
Gross hematuria	**Negative**	117 (43.8%)
	Positive	150 (56.2%)
Microscopic Hematouria	**Negative**	90 (33.7%)
	Positive	177 (66.3%)

Table 2: CT diagnosis in association with gross hematuria, microscopic hematuria and hydronephrosis.

Parameter		CT Diagnosis of Urolithiasis		P-value
		Negative	Positive	
Gross hematuria	**Negative**	7 (6%)	110 (94%)	0.037
	Positive	2 (1.3%)	148 (98.7%)	
Microscopic Hematouria	**Negative**	4 (4.4%)	86 (95.6%)	0.488
	Positive	5 (2.8%)	172 (97.2%)	
Hydronephrosis	**Negative**	9 (7.2%)	116 (92.8%)	0.001
	Positive	0 (0%)	142 (100%)	

Table 3: Diagnostic Test Accuracy of Gross Hematuria, Microhematuria, and Hydronephrosis in Reference to CT Diagnosis

Item	Gross Hematuria	Microscopic Hematuria	Hydronephrosis
Sensitivity	98.7% (95% CI: 95.2% - 99.8%)	97.2% (95% CI: 93.9% - 98.9%)	100% (95% CI: 97.4% - 100%)
Specificity	6.0% (95% CI: 2.2% - 14.3%)	4.4% (95% CI: 1.5% - 11.2%)	7.2% (95% CI: 3.2% - 15.3%)
Positive Predictive Value	98.7% (95% CI: 95.2% - 99.8%)	97.2% (95% CI: 93.9% - 98.9%)	92.8% (95% CI: 89.1% - 95.5%)
Negative Predictive Value	6.0% (95% CI: 2.2% - 14.3%)	4.4% (95% CI: 1.5% - 11.2%)	0% (95% CI: 0% - 2.7%)

DISCUSSION:

The objective of this study was to assess the diagnostic accuracy of microhematuria and macrohematuria compared to CT diagnosis as the reference standard for urolithiasis. Additionally, the study aimed to evaluate the role of hydronephrosis in diagnosing urolithiasis. By analyzing the findings related to these parameters, we can gain insights into their diagnostic performance and their potential utility in clinical practice.

Gross hematuria, characterized by visible blood in the urine, has long been recognized as a significant indicator of urolithiasis. In our study, we found that gross hematuria exhibited a high sensitivity of 98.7% in detecting urolithiasis. This indicates that gross hematuria is highly effective in identifying patients with urolithiasis when present. However, the specificity of gross hematuria was only 6.0%, suggesting a considerable number of false-positive results. This could be attributed to the fact that gross hematuria can be caused by various factors other than urolithiasis, such as urinary tract infections or bladder tumors. Therefore, while gross hematuria is a useful clinical indicator, it should be interpreted cautiously, considering the potential for false-positive results.

Microscopic hematuria, which is not visible to the naked eye and can only be detected through urine analysis, has also been explored as a potential diagnostic marker for urolithiasis. Our study revealed a high sensitivity of 97.2% for microscopic hematuria, indicating its effectiveness in identifying urolithiasis cases. However, similar to gross hematuria, the specificity of microscopic hematuria was low at 4.4%. This suggests that while microscopic hematuria is a sensitive indicator, it may yield a significant number of false-positive results. Clinicians should exercise caution and consider additional diagnostic measures when interpreting microscopic hematuria findings.

Hydronephrosis, the dilation of the renal pelvis and calyces, is often associated with urolithiasis and can be detected through imaging techniques such as CT scans. In our study, we found that hydronephrosis exhibited a sensitivity of 100%, indicating its excellent ability to identify urolithiasis cases when present. However, the specificity of hydronephrosis was only 7.2%, suggesting a high rate of false-positive results. Furthermore, the negative predictive value of hydronephrosis was 0%, indicating that a negative result for hydronephrosis does not reliably exclude urolithiasis. This highlights the limitations of using hydronephrosis as a standalone diagnostic criterion for urolithiasis.

In our study, we found that gross hematuria exhibited a high sensitivity of 98.7% in detecting urolithiasis, which aligns with the findings of the UK study. However, our study also revealed that gross hematuria had a low specificity of 6.0%, indicating a significant number of false-positive results [11]. The findings of our study emphasize the importance of a comprehensive diagnostic approach when evaluating patients with suspected urolithiasis. While gross hematuria, microscopic hematuria, and hydronephrosis can provide clues, they should be considered in conjunction with other clinical factors and imaging modalities, such as CT scans, to achieve a more accurate diagnosis. Integrating these parameters into a diagnostic algorithm can help guide clinicians in making informed decisions and optimizing patient management.

It is worth noting that our study was conducted in a specific clinical setting and with a particular sample size, which may limit the generalizability of the findings. Future research with larger and more diverse populations is warranted to validate our results and further explore the diagnostic accuracy of these parameters in different healthcare settings.

CONCLUSION:

In conclusion, while both gross hematuria and microscopic hematuria demonstrate high sensitivity in detecting urolithiasis, their low specificity highlights the potential for false-positive results. Hydronephrosis, despite its high sensitivity, exhibits limited specificity and a low negative predictive value. Therefore, a comprehensive diagnostic approach that incorporates these parameters along with clinical judgment and imaging techniques is crucial for accurate diagnosis and optimal management of patients with suspected urolithiasis.

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