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Original Research Paper

The role of CT Scan Urography in Haematuria Patients

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ABSTRACT:

Background: Hematuria can indicate serious diseases such as bladder cancer, upper urinary tract urothelial cell carcinoma (UUT-UCC), renal cell cancer, or urinary tract stones. **Aim and Objective:** To study the role of CT urography in haematuria in terms of diagnosis. **Material and Method:** This cross-sectional study was conducted in the Department of Radio-Diagnosis, Mayo Institute of Medical Sciences, Gadia, Barabanki. The data was collected from 60 patients with Haematuria from the OPD of the hospital. The patient underwent a CT examination after obtaining a detailed clinical history. **Results**: In the present study, the most common age group presented with hematuria was between 30 and 40 years old and constituted about 38.33% of the total number of cases. In this study, there was a male (43) preponderance over females (17). The most common cause of hematuria in the present study was urolithiasis, which contributed to 40% of total cases. The most common location of urolithiasis is the ureteric. **Conclusion:** The CT scan capabilities are highly accurate and specific in detecting the causes of haematuria . It can demonstrate the exact site of involvement in a very high percentage of cases. In addition to haematuria, multidetector computed tomography can detect various associated and incidental findings that may not be suspected clinically.

Keywords: CT scan, haematuria, urography

INTRODUCTION:

Haematuria is the presence of blood in the urine and may be macroscopic or microscopic. It is more strictly defined as the presence of five or more red blood cells per high-powered field in three of three consecutive centrifuged specimens, obtained at least one week apart. In the clinical setting, a positive urine dipstick reaction for the presence of blood is usually the first indication of haematuria. It may be symptomatic or asymptomatic, transient or persistent, encountered as an isolated feature or in association with other urinary abnormalities.

Hematuria can originate from any site along the urinary tract and has a wide range of causes, including calculi, neoplasm, infection, trauma, coagulopathy, and renal parenchymal disease. This makes the differential diagnosis extensive and seemingly disjointed. The concept of CT urography (CTU) is more appropriate as both the renal parenchyma and urothelium can be evaluated with one relatively non-invasive, comprehensive examination. [1]

In some cases, hematuria can indicate the presence of bladder cancer, UUT-UCC, renal cell carcinoma, or urinary tract stones. The presence of blood in the urine, whether microscopic or macroscopic, is referred to as haematuria. More precisely, it is defined as the presence of four or more red blood cells that were collected at least one week apart from one another. The presence of blood in the urine is usually the first sign of haematuria in a clinical setting. Symptomatic or asymptomatic, short-term or long-term, isolated or in conjunction with other urinary abnormalities, it can occur as a single finding or as part of a larger pattern [2].

As one of the most common urinary tract pathologies, haematuria warrants both the patient's and the treating physician's attention. One of the most common symptoms of a variety of urinary tract disorders, including calculi, neoplasms, infections, trauma, medication-induced thrombocytopenia, developmental anomalies, and diseases of the renal parenchyma, is haematuria [3]. Intravenous urography (IVU) was the first method of genitourinary imaging until the beginning of the 21st century. However, MDCT urography is now the preferred imaging technique [4]. Haematuria investigation depends on practice; however, this has changed recently. Plain flim imaging may be useful in certain situations, such as in the case of acute renal colic that results in haematuria. In order to rule out malignancy, the most sensitive imaging modalities are ultrasound and CT [5]. The detection of haematuria relies heavily on the use of ultrasound. Its sensitivity varies based on the operator's experience and the patient's body habits. Urinary tract calculi can be detected using this method. Further research shows that ultrasound is more sensitive than IVU for the

detection of urological malignancies [6]. When it comes to diagnosing hemorrhagic disease, contrast-enhanced CT has been found to be most effective. Compared to ultrasound's sensitivity of about 85% in diagnosing renal masses, its sensitivity ranges from >98% to >85% for this test. By contrast, 15 CT-U has an 85 percent higher sensitivity for diagnosing upper tract urothelial malignancy than IVU [7].

This technique is based on the acquisition of non-enhanced and enhanced CT scans of the abdomen and pelvis, including the essential acquisition of thin-section helical CT scans of the urinary tract during the excretory phase of enhancement. Multiplanar 2D and 3D reformation images are produced from axial source images during the excretory phase. 2 CT urography offers several advantages for imaging of the urinary tract: single breath-hold coverage of the entire urinary tract in the absence of respiratory misregistration, rapid imaging with optimum contrast medium pacification, and reduced partial volume effect as appropriate slices can be selected from the volumetric data. [8] The study aimed to evaluate the value of CT urography in hematuria.

MATERIALS AND METHOD:

This cross-sectional study was conducted in the Department of Radio-Diagnosis, Mayo Institute of Medical Sciences, Gadia, Barabanki, UP. The data was collected from 60 patients with haematuria from the OPD of the hospital. The patients underwent a CT examination after obtaining a detailed clinical history. Ethical clearance was obtained from the Institutional Ethical Committee, and written informed consent was obtained before carrying out the study.

Inclusion Criteria:

Patients presenting with hematuria (both microscopic and macroscopic) and ages 20 to 70.

Excluded Criteria:

Patients with cardiovascular and renal disease, as well as those who were unwilling to participate. Multidetector computed tomography was performed in ultrasonography-positive cases, in symptomatic patients with negative ultrasonography scans, and in those with suboptimal ultrasonography scans. The equipment used in our study was a HD 11 XE (Philips Medical Systems) ultrasound unit with convex and linear probes and a 128-slice multidetector CT (Philips Ingenuity).

Participants Selection:

A complete patient history regarding the chief complaints was taken, and a thorough clinical examination was carried out after taking written informed consent. Relevant laboratory investigations were done. Patients with haematuria were evaluated by both microscopic and macroscopic methods.

The patient underwent a 3-phase CT examination after obtaining informed consent in written form. The first phase is the initial non-contrast phase. The second phase is the nephrographic phase, which was acquired following a delay of 90–100 seconds after administration of 100–120 ml of intravenous iodinated contrast to evaluate the renal parenchyma.

Followed by the pyelographic phase, which was taken 8–10 minutes following administration, to evaluate the urothelium from the pelvicaliceal system to the bladder. Equipment: This was performed with a 16-slice multidetector row CT scanner (Siemens somatom scope). Scans were obtained from the kidneys to the bladder in a craniocaudal fashion, with the following scanning parameters: slice thickness: 5mm, increment thickness: 1.2 mm, pitch: 1.5, mas: 25, Kv: 130, and collimater: 300 mm. Three-dimensional (3D) reconstructions of the non-enhanced, nephrogenic, and excretory phases were performed. The follow-up diagnosis was established on the basis of histopathological findings or the findings of a urologic procedure (cystoscopy, ureteroscopy, and enhanced coronal and nephrographic phase axial images showing left ureterocele with two calculi in them). Ureterocele was later confirmed by ureteroscopy. Nephrographic coronal and pyelographic coronal images show an ill-defined heterogenously hyper-enhancing mass lesion noted in the lower pole of the left kidney. The lesion shows contrast washout in the excretory pyelographic phase, suggesting renal cell carcinoma. Later, the case was confirmed as renal cell carcinoma on histopathological examination (Fig. 1 and 2).

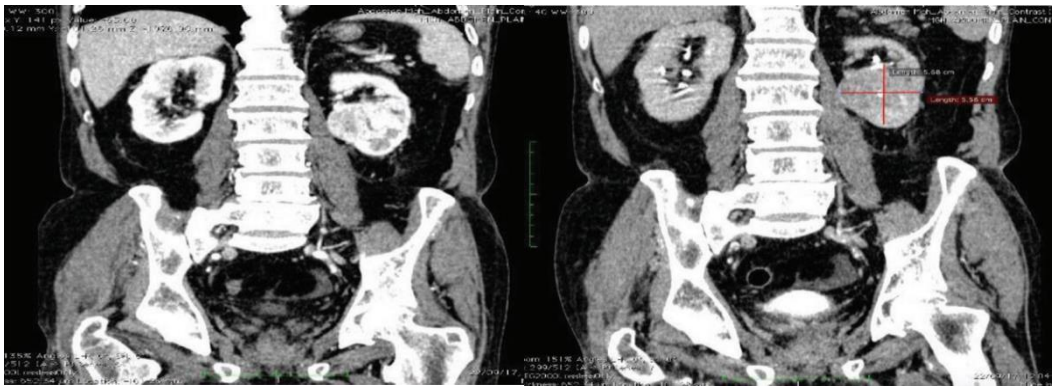

Figure-1: **Nephrographic coronal Figure 2**: **Pyelographic coronal**

Statistics Analysis:

Mean ± SD were calculated for all the parameters to examine and were differentiated by the student's t-test using SPSS 16. P-values considered significant were as follows: $P < 0.05$ is significant, and $P > 0.001$ is highly significant.

Observation and Results:

The most common age group for hematuria was 30–40 years, which constituted 38.33% of the study group, and the least common age group was 60–70 years, which constituted 8.33%. The prevalence of hematuria was more common among males (43) compared to females (17) (table 1). The prevalence of painless hematuria (38) was more common than painful hematuria (22). Macroscopic hematuria constituted 53.33%, which was more than microscopic hematuria (table 3). Abdominal pain was the most common complaint other than hematuria, followed by fever (table no. 8). In 60 patients, the cause of hematuria was divided into urolithiasis, infective, inflammatory, congenital, traumatic, neoplasms, and other miscellaneous conditions (table 5).

Table No. 1: Distribution of patients according to gender

Gender	No. of patients (60)	%
Male	43	71.67
Female	17	28.33

Table No. 2: Distribution of patients according to age

Age (years)	No. of patients (60)	%
20-30	10	16.67
30-40	23	38.33
40-50	15	25
50-60	12	20
60-70	5	8.33
Total	60	100

Table No. 3: Patients according to the nature of hematuria

The nature of hematuria	No. of patients (60)	%
Microscopic hematuria	32	53.33
Macroscopic hematuria	28	46.67

Table No. 4: Pain among patients with hematuria

	No. of patients (60)	%
Painless	38	63.33
Painful	22	36.67

Table 5: Distribution of patients according to cause of hematuria

Cause of hematuria	No. of patients (60)	%
Urolithiasis	25	41.67
Renal cell carcinoma	4	6.67
Angiomyolipoma	1	1.67
Pyelonephritis	2	3.33
Renal abscess	2	3.33
Normal	6	10
Renal complex cysts	5	8.33

Urinoma	2	3.33
PCKD	1	1.67
Vesico-vaginal fistula	1	1.67
Ectopic kidney	1	1.67
Renal hydatid	1	1.67
Urogenital TB	1	1.67
Xanthogranulomatous pyelonephritis	1	1.67
Intraperitoneal bladder rupture	1	1.67
Bladder carcinoma	3	5
Cystitis	3	5
Horseshoe kidney	2	3.33

Table 6: Distribution of patients according to location of calculus

Location of calculus	**No. of patients (24)**	**%**
Renal	6	25
PUJ	5	20.83
Ureteric	7	29.17
VUJ	6	25
Causes of hydronephrosis		
Renal calculus	3	12.5
PUJ calculus	5	20.83
Ureteric calculus	7	29.17
VUJ calculus	6	25
Bladder carcinoma	1	4.17
PUJ obstruction	1	4.17
Urogenital TB	1	4.17

CT urography detects 24 patients with urolithiasis as the cause of hematuria, including renal, PUJ, ureteric, and VUJ calculi, which constitutes nearly 40% of the total number of cases and thus becomes the main cause of hematuria in the present study (table 6).

Most of the urolithiasis patients present with painful microscopic hematuria, and in the present study, the most common location of urolithiasis was ureteric (29.17%), followed by VUJ (table no. 6).

Table 7. Distribution of patients with urolithiasis and neoplasms according to age group

Age group	**Total Number of patients**	**Present with urolithiasis**	**P- value**
50yrs and <50yrs	48	15	0.83
>50yrs	12	8	
		Present with neoplasm	
50yrs and <50yrs	48	3	0.012
>50yrs	12	7	

The most common age group having hematuria was below 50 years old, constituting nearly 83.33% of total urolithiasis patients. Though the below-50 age group dominates with the number of patients, there was no clear significance between the two as the p-value came in at nearly 0.83. (P<0.05 is significant) (table 5).

Most of the cases of neoplasms in the present study were older than 50 years, and the table depicts the relationship between age group and neoplasms as significant, with a p value between them around 0.012, which was less than 0.05.

Table No. 8: Clinical manifestations other than hematuria

Clinical manifestations	No. of patients (60)	%
Abdominal pain	48	80
Abdominal mass	4	6.67
Fever	11	18.33
Weight loss	7	11.67

Most of the cases Clinical manifestations are abdominal pain (80% flowed by fever), weight loss, and abdominal mass.

Table No. 9: Distribution of neoplasms according to location along the urinary tract.

Neoplasms	No. of patients (60)	%
Renal	42	70
Only vesicle	4	6.67
Vesicle+ Ureteric extension	14	23.33

DISCUSSION:

The present study comprised 60 patients who presented with hematuria (both macroscopic and microscopic) and were referred to the radiology department from the urology department for workup with CT urography. All the patients underwent CT urography, and a diagnosis was established after analyzing all the phases of the study with the required post-processing techniques.

The present study found that the most common age group for hematuria was 30–40 years, which constituted 38.33% of the study group, and the least common age group was 60–70 years, which constitutes 8.33%. The prevalence of hematuria was more common among males (43) compared to females (17) (table 1). The prevalence of painless hematuria (38) was more common than painful hematuria (22). Macroscopic hematuria constituted 53.33%, which was more than microscopic hematuria (table 3). Abdominal pain was the most common complaint other than hematuria, followed by fever (table no. 8). In 60 patients, the cause of hematuria was divided into urolithiasis, infective, inflammatory, congenital, traumatic, neoplasms, and other miscellaneous conditions (table 5).

In the present study, CT urography detected 24 patients with urolithiasis as the cause of hematuria, including renal, PUJ, ureteric, and VUJ calculi, which constitutes nearly 40% of the total number of cases and thus becomes the main cause of hematuria in the present study (table 6). Most of the urolithiasis patients present with painful microscopic hematuria, and in the present study, the most common location of urolithiasis was ureteric (29.17%), followed by VUJ (table no. 6). The most common age group having hematuria was below 50 years old, constituting nearly 83.33% of total urolithiasis patients. Though the below-50 age group dominates with the number of patients, there was no clear significance between the two as the p-value came in at nearly 0.92. (P<0.05 is significant) (table 5).

Most of the cases of neoplasms in the present study were older than 50 years, and the table depicts the relationship between age group and neoplasms as significant, with a p value between them around 0.01, which was less than 0.05. A similar study, The Role of Computerized Tomographic Urography in the Initial Evaluation of Hematuria by Albani JM et al. (2007), studied the source of hematuria in 107 patients and concluded the most common cause of hematuria was urolithiasis (26%).. Most of the urolithiasis patients present with painful microscopic hematuria, and in the present study, the most common location of urolithiasis was the ureteric (35%), followed by the vj. A similar study on the role of multi-detector row computed tomography urography (MDCTU) in the evaluation of microscopic hematuria in adults by Mahmoud MA et al. (2015) described urolithiasis as the cause of microscopic hematuria in about 24% of patients [10].

In the present study, the most common age group having hematuria was below 50 years, constituting nearly 70% of total urolithiasis patients. Though the below-50 years age group dominates with the number

of patients, there was no clear significance between the two as the p value came in at nearly 0.93. ($P<0.05$ is significant).

The age group correlation shown above thus signifies that a higher number of patients below 50 years of age occurred by chance. All of these calculi were identified on the unenhanced CT images. CT urography had no false-negative results, which means no calculi were detected either surgically or by other imaging techniques after a negative CT urogram. On CTU, other than the detection of calculi, many other clinically relevant observations were also made, which helps in management.Signs of obstruction like perinephric fat stranding, periureteric edema, hydroureter, hydronephrosis, and lateral conal fascial thickening were clearly depicted. Most of the urolithiasis patients also show hydronephrosis, the most common cause being ureteric calculus. Hence, the present study is in accordance with the studies conducted bySong JH et al. and Maheshwari E et al., where male-female ratios were 1.17:1 and 1.47:1, respectively. [11,12]A male patient of age 35 presented with hematuria, and CT urography revealed the presence of cystocele with VUJ calculus. Thus, VUJ calculus 53 as the cause of hematuria and ureterocele was confirmed by ureteroscopy, and thus psedoureterocele of VUJ calculus was ruled out. Another female patient aged 38 years presented with hematuria on a CT urogram, which revealed a left ectopic kidney with left ureteric calculus and mild hydronephrosis of the left ectopic kidney. The cause of the hematuria was concluded to be ureteric calculus rather than the ectopic kidney.

In a similar study, Kumar S et al. (2011) described a similar case with an ectopic kidney presenting with hematuria and revealed pelvic calculus with hydronephrosis, which was found to be the cause of hematuria when evaluated through contrast-enhanced computed tomography. [13] Maheshwari E. et al. reported bladder carcinoma (9%) and calculi as the leading causes of haematuria on MDCT. In the present study, bladder carcinoma (18%) and calculi (20%) were the most common detected causes of haematuria on MDCT (18%) [12].

In the present study, various infective causes along with their complications were noted affecting both the upper and lower urinary tracts, including pyelonephritis, renal abscess, renal hydatid, urogenital tuberculosis, and cystitis. In this study, infectious causes constitute about 36.67%, and most of them present with painful hematuria. The most common symptom other than hematuria is fever.

In the present study, there were 2 cases of acute pyelonephritis. One case was a 32-year-old male patient who presented with fever and right flank pain along with painless microscopic hematuria. A CT urogram showed an enlarged right kidney with perinephric fat stranding, and in the nephrogenic phase, a striated nephrogram. Another case was a 42-year-old female who presented with pelvic pain and fever along with hematuria and showed an ectopic kidney with focal enlargement and bulging on the left side with various hypodensities in the cortex noted in the nephrogenic phase, along with the right kidney showing similar findings with perinephric fat stranding. In a similar study by Tsao YT et al. (2008), they described a similar case of ectopic kidney with focal pyelonephritis as the cause of hematuria, which was confirmed by contrast-enhanced computed tomography. [14]

Ishimitsu DN et al. (2010) described a similar case presented with microscopic hematuria, left flank mass, and hydatiduria and concluded that contrast administered CT was necessary to know the enhancement of the septa and wall. Gharde P et al. (2012) reported a similar case of a 40-year-old male patient who presented with intermediate hematuria and hydatiduria for 10 years. A CT revealed a multiseptated cystic lesion, which surgery confirmed as renal hydatid. [14,15]

Figueiredo AA et al. (2008) described a few patients who presented with hematuria on urine examination along with other constitutional symptoms of tuberculosis, and they described bladder involvement in most of the hematuria patients. Altintepe L et al. (2005) depicted about 35% of urogenital tuberculosis patients having contractedthimble bladder on imaging and described how about 12% of patients presented with macroscopic hematuria. [16-17]

In a sample of 91 patients presenting with painless hematuria by CT urography, about two patients were confirmed to have cystitis. Shinagare AB et al. (2011) described many infective and inflammatory causes of bladder, such as cystitis, which will simulate bladder carcinoma on CT urography [18], and concluded that they should be confirmed by cystoscopic biopsy and proceed for further management accordingly. Nataluk EA et al. (1995) reviewed 12 patients with a clinicopathogenic diagnosis of xanthogranulomatous pyelonephritis (XGP) to determine if a computed tomography (CT) scan is the imaging procedure of choice for diagnosis [19]. Nine of 10 patients (90%) who were evaluated by CT scan had the correct diagnosis made prior to nephrectomy, and it was concluded that CT has proven to be the most accurate imaging study to evaluate xanthogranulomatous pyelonephritis. Gupta S et al. (2010) discussed a case of a female patient with similar findings to the present study: a 17-year-old female who presented with a 2-month history of increasing abdominal pain and intermittent episodes of increased frequency and dysuria. A plain antero-posterior radiograph of the abdomen revealed a left staghorn calculus. A computed tomography scan with intravenous contrast revealed a low-density inflammatory area and reduced cortical dye uptake on the left renal parenchyma as compared to the opposite

side. A dimercapto-succinic acid renal scan revealed that the affected kidney contributed 18% of differential function. [20]

The nephrogenic phase is helpful in diagnosing upper urinary tract injuries, mostly renal injuries, and the pyelographic phase is helpful in diagnosing lower urinary tract injuries, mostly bladder injuries. In a similar study by Ramchandani P et al. (2009), the role of CT urography along with other imaging modalities in genitourinary trauma was described, and it was depicted that CT urography was helpful in revealing both the upper and lower urinary tract. In a similar study, Blick CG et al. (2012) concluded that there was a clear advantage to the diagnostic strategy using CT urography and flexible cystoscopy as a triage test for rigid cystoscopy and follow-up, in which patients with a positive CT urography score for bladder cancer were directly referred for rigid cystoscopy, but all other patients underwent flexible cystoscopy. [21-22] Urolithiasis contributes to 80% of the total number of cases with hydronephrosis, with the ureteric location of calculus being the most common cause of urolithiasis. The diagnostic accuracy of CT urography in evaluating the etiology of hematuria. In the present study group of 60 patients, all the patients with upper urinary tract pathologies were diagnosed accurately with CT urography.

CONCLUSION:

The enhanced phase of CT urography is useful in detecting urolithiasis; the nephrographic phase is mostly useful for upper urinary tract pathologies; and the pyelographic phase is useful for detecting lower urinary tract pathologies. According to the present study, CT urography had more diagnostic accuracy in detecting upper urinary tract pathologies than lower urinary tract pathologies. Lower urinary tract pathologies, especially bladder carcinoma and cystoscopy, had better diagnostic accuracy than CT urography. However, CT urography gives a good roadmap for evaluating patients suspected of having lower urinary tract pathologies before performing a cystoscopy, and combining both would yield a high diagnostic outcome. According to the present study, CT urography showed high diagnostic values with a combination of unenhanced, nephrographic, and excretory phases.

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