ORIGINAL RESEARCH PAPER

Radiology

KEY WORDS:

ROLE OF MULTIDETECTOR COMPUTED TOMOGRAPHY UROGRAPHY IN DIFFERENTIATING BENIGN AND MALIGNANT CAUSES OF HEMATURIA

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ABSTRACT

MDCT urography has emerged as a comprehensive imaging modality for evaluation of hematuria. This study evaluates the role of MDCTU in differentiating benign and malignant causes of painless hematuria in 105 patients. Maximum no of patients are of Nephrolithiasis and ureterolithiasis. Second most common etiology for hematuria found to be bladder neoplastic lesion and renal cell carcinoma. Other causes are renal injury , polycystic lesion and infective affection of urinary tract.

INTRODUCTION

Hematuria, defined as the presence of blood in urine, is one of the most common urological presentations, accounting for over 20% of urological evaluations. It is classified as either gross hematuria, where blood is visible to the naked eye, or microscopic hematuria, where red blood cells are detected on urine examination despite normal urine appearance. Hematuria may originate from any part of the urinary tract, from the kidneys to the urethra, and should always be considered clinically significant until a serious cause is excluded.

The prevalence of hematuria varies widely, with asymptomatic microscopic hematuria reported in 0.18–38.7% of individuals and detected in approximately 2–4% of adults during routine screening. Gross hematuria is less common but is associated with a higher likelihood of significant pathology. Similar prevalence patterns have been reported in Indian studies. Importantly, hematuria is often the first manifestation of urinary tract malignancy, particularly bladder cancer. The incidence of genitourinary malignancy is approximately 3% in patients with microscopic hematuria and rises to 10–20% in those presenting with gross hematuria. The causes of hematuria are diverse and include urinary tract infections, urolithiasis, trauma, inflammatory disorders, congenital anomalies, and neoplasms. Therefore, accurate evaluation is essential to identify the underlying etiology and guide appropriate management. Conventional assessment includes clinical history, physical examination, laboratory investigations, cystoscopy, cytology, and imaging studies.

Historically, intravenous urography (IVU) served as the primary imaging modality for hematuria evaluation. Ultrasonography (USG) remains a safe, non-invasive, and readily available technique for assessing the kidneys and urinary bladder. However, its sensitivity is limited for detecting small renal masses, urothelial tumors, and certain urinary calculi.

The introduction of Multidetector Computed Tomography Urography (MDCTU) has significantly improved the diagnostic evaluation of hematuria. MDCTU provides rapid acquisition of high-resolution volumetric data, enabling detailed multiplanar and three-dimensional visualization of the entire urinary tract in a single examination. It offers superior spatial resolution, excellent anatomical detail, and improved detection of urinary tract abnormalities compared with conventional imaging methods.

MDCTU has largely replaced excretory urography in many centers and is increasingly regarded as the imaging modality of choice for patients with hematuria. It effectively detects urinary calculi, renal and urothelial tumors, urinary tract obstruction, and associated complications. By combining the advantages of excretory imaging and cross-sectional anatomy, MDCTU serves as a comprehensive "one-stop" investigation, facilitating early diagnosis, accurate characterization of pathology, and optimal treatment planning in patients presenting with hematuria.

Aim

To evaluate the role of MDCT urography in differentiating benign and malignant causes of painless hematuria.

Materials and Methods

Prospective observational study involving 105 patients with painless hematuria evaluated using USG and three-phase MDCT urography.Patients above 10 years of age presenting with hematuria (microscopic and macroscopic) who will give consent will be included in this study. Exclusion Criteria:Patient below 10 years of age.Pregnant and lactating females.Severe renal failurPrevious allergic reaction to contrast media.Patients not willing to particiate in study.

TECHNIQUE OF MDCTU

- CT Urography (The patients underwent a 3 phase CT examination) was done.16 SLICE MDCT Machine was used.First phase was the initial non-contrast phase. Second phase was the nephrographic phase, which was acquired following a delay of 90- 100 seconds after administration of 100-120ml of intravenous iodinated contrast, to evaluate the renal parenchyma.
- Followed by the pyelographic phase which was undertaken 8 -10 minutes following contrast administration, to evaluate the urothelium from the pelvicaliceal system to the bladder.
- **Equipment:** This was performed with a 16slice Multidetector row CT scanner. Scans were obtained from the kidneys to the bladder in a craniocaudal fashion, with the following scanning parameters as slice thickness5mm, increment thickness-1.2mm, pitch-1.5, mas-25, Kv130 and Collimater fov-300mm.
- Three-dimensional (3D) reconstructions of the non enhanced, nephrogenic phase and excretory phase were performed.
- The follow up diagnosis was established on the basis of histopathology findings or the findings at a urologic procedure (cystoscopy, ureteroscopy). The definitive histopathological diagnosis was obtained in cases undergoing surgery in our institute.

PROTOCOL

Most medical institutions employ a three-phase MDCTU protocol for the evaluation of patients with hematuria. Most three-phase MDCTU protocols comprise an initial non-contrast phase to detect urinary tract calculi and a second phase, i.e. the nephrographic phase, which is acquired following a delay of 90-100 seconds after administration of 120 ml of intravenous iodinated contrast, to evaluate the renal parenchyma. This is followed by the pyelographic phase taken 5-10 minutes following contrast administration, to evaluate the urothelium from the pelvicaliceal system to the bladder. These three-phase protocols are used at most institutions as they allow a thorough evaluation of the urinary tract for the most common causes of hematuria i.e. urinary tract calculi, renal neoplasms and urothelial tumors. However, this approach has three main disadvantages: 1) it involves a very high radiation dose and 2) it is time consuming, a factor which can impact significantly on increasing radiological daily workloads, 3) it increases the number of images for review by the radiologist.[14,]

To address these disadvantages of three-phase technique, a two-phase protocol has been developed for the evaluation of patients with hematuria.[94]

As part of a two-phase MDCTU protocol, a non-contrast scan is initially obtained from the top of the kidneys to the base of the bladder. The non-contrast scan is performed without intravenous and oral contrast to exclude urinary tract calculi. The omission of oral contrast is to facilitate 3D reformations of the contrast-filled ureters and collecting systems if they are considered necessary at the end of the study. An unenhanced CT without oral or intravenous contrast scan has been shown to be the most sensitive test in the evaluation of the urinary tract for calculi. For those patients in whom the indication for MDCTU is microscopic hematuria, the following policy with regard to requirement for contrast-enhanced study is used. The requirement for contrast-enhanced study is dependent on the findings on the unenhanced study and on the age and clinical presentation of the patient. If urinary tract calculi are detected on the non-contrast scan in a patient less than 40 years, the study is terminated. However, if urinary tract calculi are not detected in patients less than 40 years old or if findings do not correlate with clinical findings, a contrast enhanced scan is performed. The rationale for not giving intravenous contrast to patients less than 40 years is the negligible incidence of urological malignancy reported in patients in this age group.[54,95] A contrast-enhanced "nephropyelographic phase" scan is obtained in all patients with hematuria, greater than 40 years old, and in all patients with macroscopic hematuria regardless of the findings on initial unenhanced study. This policy is based on the current guidelines of the American Urological Association Best Practice Policy.[54]

Scanning Parameters

CT scanning was performed extending from the top of the kidneys to the base of the bladder in an approximately 20 second breath-hold using a 4-channel multislice helical scanner. Images were acquired with a 2.5 mm detector configuration and a non-overlapping slice-pitch of 1.5:1 (table speed 15 mm/rotation). For diagnostic evaluation, contiguous axial images are reconstructed with 5-mm slice thickness. When needed, 2.5 mm thin slices (slice profile 3.2 mm at FWHM) with 50% overlap are obtained for reconstructing coronal and sagittal images of the ureters. Thinner slices are especially important in evaluation of renal vessels, and small and subtle renal abnormalities.

Three-dimensional (3D) reconstruction

Three-dimensional (3D) reconstruction of the image data includes thick and thin slab coronal and sagittal maximum-intensity-projection for kidneys, ureters and urinary bladder. When MDCTU was introduced initially, the majority of studies were supplemented with 3D reconstructions. The 3D reconstructions aided in convincing urologists of the benefits of this technique over excretory urography as it allowed them to view images in the coronal plain similar to excretory urography images.

In addition, for radiologists, experience in the characterization of certain pathologies particularly those of the renal papillae, such as renal tubular ectasia and papillary necrosis had been gained by evaluation of excretory urography images, which were acquired in the coronal plane and initially difficulties were encountered in characterizing these pathologies on transverse plane images.[96] 3D reformations particularly in coronal plane are very useful for characterizing these conditions.[96] Caoili et al. have reported that 3D reconstructions are a useful aid to radiologists and urologists as a "bridge" between excretory urography data and transverse MDCTU data. We also concur that as additional experience is gained with MDCTU, most urinary tract pathologies will be characterized in the transverse plane, and 3D reformations may no longer be necessary. Furthermore, it should also be emphasized that 3D reformations suffer the same disadvantages as excretory urography if the transverse images are not reviewed in association. Many ureteral and bladder wall abnormalities are frequently detected on transverse images and can be missed on 3D reformats.[96]

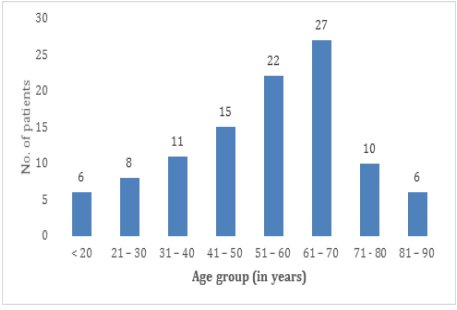
OBSERVATION AND RESULTS

The present study was conducted among 105 patients presenting with haematuria. The findings are as follows:

Table 2: Distribution of patients as per age group

Age group	Number	Percentage
< 20	06	5.71
21 – 30	08	7.62
31 – 40	11	10.48
41 – 50	15	14.29
51 – 60	22	20.95
61 – 70	27	25.71
71 - 80	10	9.52
81 – 90	06	5.71
Total	105	100

Graph 1: Bar graph depicting distribution of patients as per age group



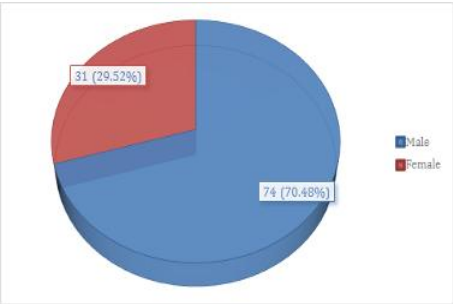
As per the above table, it was observed that maximum patients belonged to age group of 61-70 years that is 27 (25.71%) followed by 22 (20.95%) patients between 51-60 years of age and 15 (14.29%) between 41-50 years of age. 6 (5.71%) patients each belonged to extreme age groups that is less than 20 years and 81-90 years.

The mean age of patients was 54.53 ± 17.87 years with minimum age being 13 years and maximum age being 87 years.

Table 3: Distribution of patients as per gender

Gender	Number	Percentage
Male	74	70.48
Female	31	29.52
Total	105	100

Graph 2: Pie diagram depicting distribution of patients as per gender

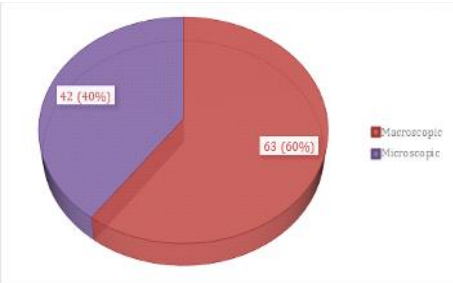


We found a male preponderance in the study with 74 (70.48%) patients being males and 31 (29.52%) being females. The male:female ratio was 2.39:1.

Table 4: Distribution of patients as per type of haematuria

Type of haematuria	Number	Percentage
Macroscopic	63	60.00
Microscopic	42	40.00
Total	105	100

Graph 3: Pie diagram depicting distribution of patients as per type of haematuria

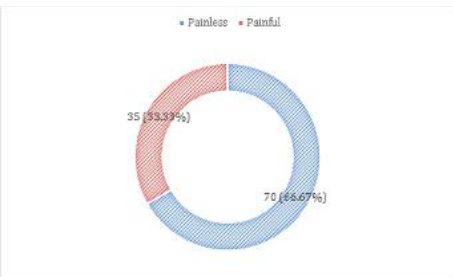


It was seen that 63 (60%) had macroscopic haematuria while 42 (40%) had microscopic haematuria.

Table 5: Distribution of patients as per type of haematuria based on pain

Type of haematuria based on pain	Number	Percentage
Painless	70	66.67
Painful	35	33.33
Total	105	100

Graph 4: Donut diagram depicting distribution of patients as per type of haematuria based on pain

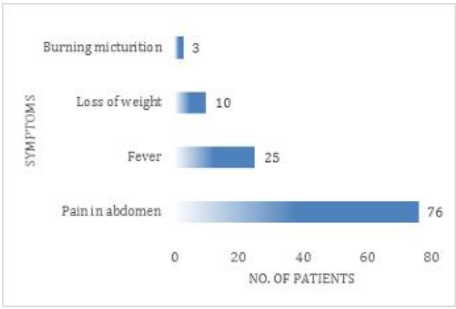


Based on pain, majority of the patients 70 (66.67%) had painless haematuria while one third patients that ie 35 (33.33%) had painful haematuria.

Table 6: Distribution of patients as per symptoms (n = 105)

Symptoms	Number	Percentage
Pain in abdomen	76	72.38
Fever	25	23.81
Loss of weight	10	9.52
Burning micturition	03	2.91

Graph 5: Bar graph depicting distribution of patients as per symptoms (n = 105)

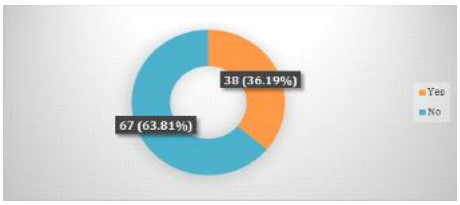


Pain in the abdomen was the most common complaint as seen in 76 (72.38%) patients followed by fever among 25 (23.81%), loss of weight in 10 (9.52%) and burning micturition in 3 (2.91%).

Table 7: Distribution of patients as per past operative history

Past operative history	Number	Percentage
Yes	38	36.19
No	67	63.81
Total	105	100

Graph 6: Donut diagram depicting distribution of patients as per past operative history

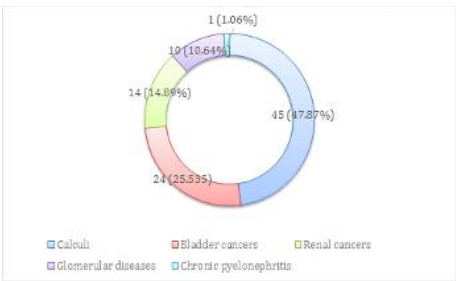


Out of all the patients, 38 (36.19%) patients had a past operative history while 67 (63.81%) did not.

Table 8: Distribution of patients as per histopathological findings

Histopathological findings	Number	Percentage
Calculi	45	47.87
Bladder cancers	24	25.53
Renal cancers	14	14.89
Glomerular diseases	10	10.64
Chronic pyelonephritis	01	1.06
Total	94	100

Graph 7: Donut diagram depicting distribution of patients as per histopathological findings

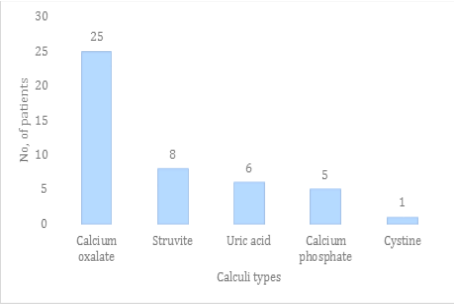


On histopathological tests, we found that the most common finding was calculi as seen in 45 (47.87%) cases followed by bladder cancer in 24 (25.53%), renal cancers, 14 (14.89%). Findings of 10 (10.64%) showed glomerular diseases, out of which 3 cases showed acute infective glomerular, nephritis, two cases showed chronic glomerulonephritis, 2 showed IgA nephropathy, 1 case each showed Lupus Nephritis, Minimal change disease and Focal segment glomerulonephritis. 1 (1.06%) patients findings showed chronic pyelonephritis.

Table 9: Distribution of calculi types as per histopathology

Calculi types as per histopathology	Number	Percentage
Calcium oxalate	25	55.55
Struvite	08	17.78
Uric acid	06	13.33
Calcium phosphate	05	11.11
Cystine	01	2.22
Total	45	100

Graph 8: Bar graph depicting distribution of calculi types as per histopathology

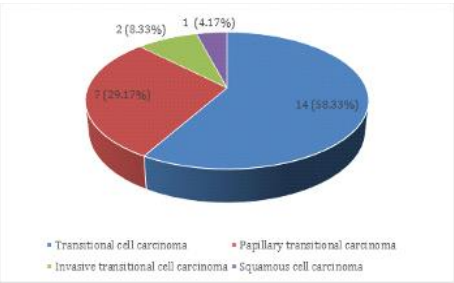


When the types of calculi were further categorised, we found that calcium oxalate stones were the most common as found in 25 (55.55%), followed by struvite stones in 8 (17.78%), uric acid stones in 6 (13.33%), calcium phosphate stones among 5 (11.11%) and one case caused due to cystine stone i.e. 1 (2.22%).

Table 10: Distribution of bladder cancer cases as per histopathology

Bladder cancer cases as per histopathology	Number	Percentage
Transitional cell carcinoma	14	58.33
Papillary transitional carcinoma	07	29.17
Invasive transitional cell carcinoma	02	8.33
Squamous cell carcinoma	01	4.17
Total	24	100

Graph 9: Pie chart depicting distribution of bladder cancer cases as per histopathology

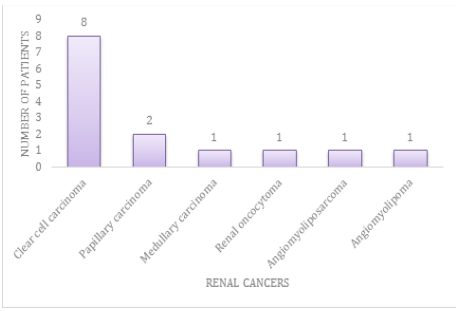


The above table and graph shows distribution of bladder cancer cases as per histopathology. Majority of the cases were of transitional cell carcinoma that is 14 (58.33%), followed by popular transitional carcinoma in seven (29.17%). Invasive transitional cell carcinoma constituted to (8.33%) cases while cell carcinoma was seen in one (4.17%).

Table 11: Distribution of renal cancer cases as per histopathology

Renal cancer cases as per histopathology	Number	Percentage
Clear cell carcinoma	08	57.14
Papillary carcinoma	02	14.29
Medullary carcinoma	01	7.14
Renal oncocytoma	01	7.14

Graph 10: Bar graph depicting distribution of renal cancer cases as per histopathology

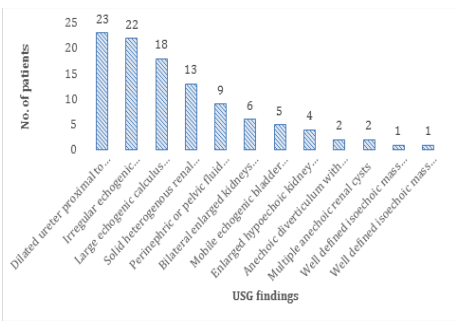


When renal cancer cases were distributed as per histopathology, the most common renal cancer found was clear cell carcinoma in eight (57.14%) cases, followed by papillary carcinoma in 2 (14.29%) cases. One (7.14%) case each had mere carcinoma, renal oncocytoma, angiomyoliposarcoma and angiomyolipoma.

Table 12: Distribution of patients as per USG findings

USG findings	Number	Percentage
Dilated ureter proximal to echogenic calculus with acoustic shadow	23	21.90
Irregular echogenic intravesical mass	22	20.95
Large echogenic calculus with posterior acoustic shadowing and dilated pelvicalyceal system	18	17.14
Solid heterogenous renal mass with increased vascularity	13	12.38
Perinephric or pelvic fluid collection	09	8.57
Bilateral enlarged kidneys with increased cortical echogenecity	06	5.71
Mobile echogenic bladder calculus	05	4.76
Enlarged hypoechoic kidney with loss of corticomedullary differentiation	04	3.81
Anechoic diverticulum with internal echogenic lesion	02	1.90
Multiple anechoic renal cysts	02	1.90
Well defined isoechoic mass at upper pole of R kidney with central hypoechoic central scar	01	0.95
Total	105	100

Graph 11: Bar graph depicting distribution of patients as per USG findings



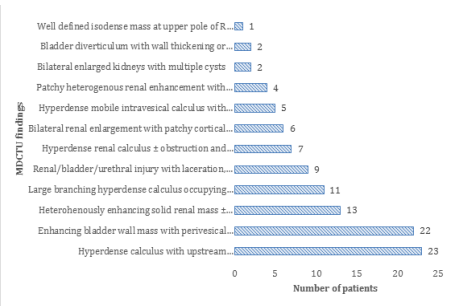
On USG, maximum patients showed dilated ureter proximal to echogenic calculus with acoustic shadow 23 (21.90%), 22 (20.95%) showed irregular echogenic intravesical mass. 18 (17.14%) showed large echogenic calculus with posterior acoustic shadowing and dilated pelvicalyceal system and 13 (12.38%) showed solid heterogeneous renal mass with increased vascularity. Nine cases showed perinephric or

pelvic fluid collection, and six cases showed bilateral enlarged kidneys with increased cortical echogenicity.

Table 13: Distribution of patients as per MDCTU findings

MDCTU findings	Number	Percentage
Hyperdense calculus with upstream hydroureteronephrosis	23	21.90
Enhancing bladder wall mass with perivesical fat invasion ± hydroureronephrosis	22	20.95
Heterohenously enhancing solid renal mass ± necrosis/calcification	13	12.38
Large branching hyperdense calculus occupying renal pelvis ± calyces with hydronephrosis, cortical thinning and perinephric fat stranding	11	10.48
Renal/bladder/urethral injury with laceration, hematoma or contrast extravasation	09	8.57
Hyperdense renal calculus ± obstruction and hydronephrosis	07	6.67
Bilateral renal enlargement with patchy cortical enhancement	06	5.71
Hyperdense mobile intravesical calculus with cystitits	05	4.76
Patchy heterogenous renal enhancement with perinephric fat stranding	04	3.81
Bilateral enlarged kidneys with multiple cysts	02	1.90
Bladder diverticulum with wall thickening or enhancing mass	02	1.90
Well defined isodense mass at upper pole of R kidney with central hypodense scar	01	0.95
Total	105	100

Graph 12: Bar graph depicting distribution of patients as per MDCTU findings

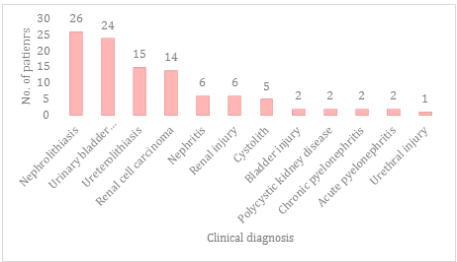


On MDCTU, the most frequent finding was hyperdense calculus with upstream hydroureteronephrosis 23 (21.90%), followed by enhancing bladder wall mass with perivesical fat invasion with or without hydrouretero nephrosis 22 (20.95%). Heterohenously enhancing solid renal mass ± necrosis/calcification was seen in 13 (12.38%), Large branching hyperdense calculus occupying renal pelvis ± calyces with hydronephrosis, cortical thinning and perinephric fat stranding was seen in 11 (10.48%) cases, Hyperdense renal calculus ± obstruction and hydronephrosis in 7 (6.67%), Hyperdense mobile intravesical calculus with cystitits in 5 (4.76%) and Patchy heterogenous renal enhancement with perinephric fat stranding in 4 (3.81%) cases. 2 (1.90%) cases each showed Bilateral enlarged kidneys with multiple cysts and Bladder diverticulum with wall thickening or enhancing mass while 1 (0.95%) case showed Well defined isodense mass at upper pole of R kidney with central hypodense scar on MDCT.

Table 14: Distribution of patients as per clinical diagnosis

Clinical diagnosis	Number	Percentage
Nephrolithiasis	26	24.76
Urinary bladder carcinoma	24	22.86
Ureterolithiasis	15	14.29
Renal cell carcinoma	14	13.33
Nephritis	06	5.71
Renal injury	06	5.71
Cystolith	05	4.76
Bladder injury	02	1.90
Polycystic kidney disease	02	1.90
Chronic pyelonephritis	02	1.90
Acute pyelonephritis	02	1.90
Urethral injury	01	0.95
Total	105	100

Graph 13: Bar graph depicting distribution of patients as per clinical diagnosis



The above table and graphs show the distribution of patients as per clinical diagnosis. In our study, maximum cases were of nephrolithiasis 26 (24.76%), followed by urinary bladder carcinoma 24 (22.86%), followed by ureterolithiasis 15 (14.29%), renal cell carcinoma, 14 (13.33%). Six (5.71%) cases, each were of nephritis and renal injury and five (4.76%) cases were of cystolith. Bladder injury, polycystic, kidney disease, chronic pyonephritis, acute pyonephritis, comprised on 2 (1.90%) cases each while 1 (0.95%) patient had urethral injury

CASE IMAGES

Case 1: 53 yr old female came with c/o hematuria and left flank pain.

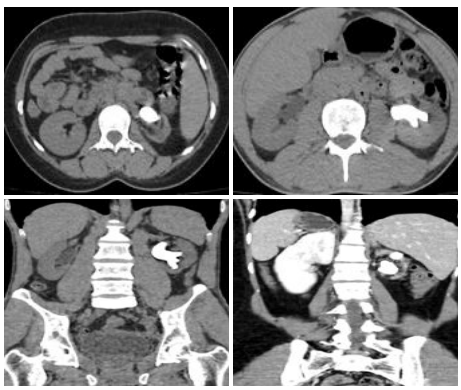


Figure 22 (a,b,c,d): Staghorn calculus

Case 2: 58 yr old male came with c/o painless hematuria with increased frequency

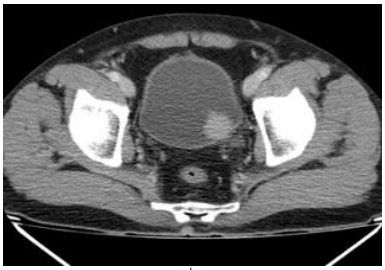


Figure 23: Urinary bladder carcinoma

Case 3: 33 yr old female came with c/o hematuria and recurrent UTI

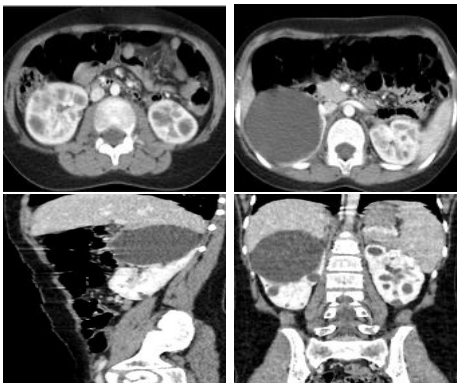


Figure 24(a,b,c,d): Polycystic kidney disease

Case 4: 45 yr old male came with c/o Hematuria and right flank pain

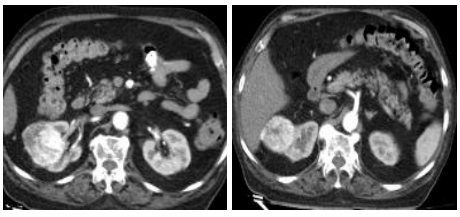


Figure 25(a,b): Oncocytoma

Case 5: 55 yr old male came with c/o fever with chills, abdominal pain and vomiting since 10 days

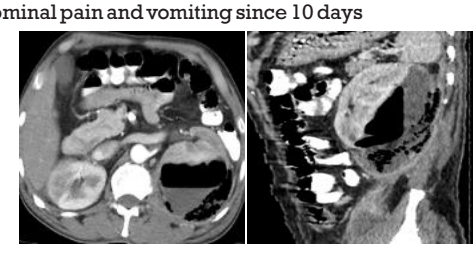


Figure 26(a,b): Emphysematous Pyelonephritis

Case 6: 45 yr old female came with c/o hematuria and right flank pain since 10 days.

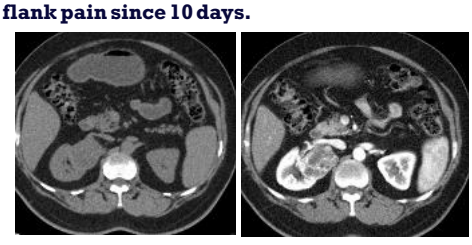


Figure 27(a,b): Renal cell carcinoma

Case 7: 59 yr old female came with c/o left flank pain, abdominal mass and hematuria since 15 days

Figure 28 (a,b): Angiomyolipoma

Case 8: Renal cell carcinoma of the right kidney with invasion of IVC and right renal vei

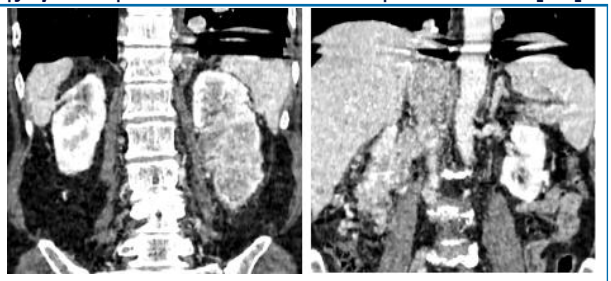


Figure 29(a,b): Renal cell carcinoma of the right kidney with invasion of IVC and right renal veinn

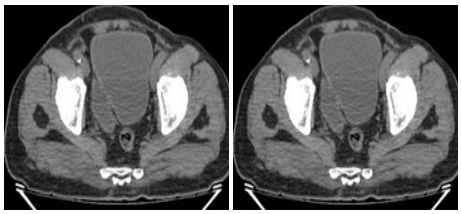


Figure 30: Bladder diverticula

DISCUSSION

The present longitudinal follow-up study was conducted to evaluate the diagnostic performance and clinical utility of Multidetector Computed Tomography Urography (MDCTU) in patients presenting with hematuria at a tertiary care center. Hematuria remains a clinically significant symptom due to its wide etiological spectrum, ranging from benign self-limiting conditions to life-threatening malignancies. Accurate and timely imaging evaluation is therefore paramoutIn the present study, it was observed that maximum patients belonged to age group of 61-70 years that is 27 (25.71%) followed by 22 (20.95%) patients between 51-60 years of age, indicating that elderly patients form a major proportion of those undergoing MDCTUrography. This aligns with the well-established epidemiological understanding that the risk of urothelial malignancy, renal masses, and complex urolithiasis increases with advancing age, making MDCTU particularly valuable in older populations.

However, in studies by Thakur MS et al and Geetanjali YS et al, maximum patients were in age group 51 – 60 which was the second most common in our study.[81,82] Higher prevalence in lower age groups were seen in studies by Musheer Ahmed M et al and Parate R et al ranging from 21 to 40 years.[83,88] These findings likely reflect regional differences in etiological patterns—particularly a higher burden of urolithiasis and infectious causes among younger individuals in some populations.

The mean age of patients in our study was 54.53 ± 17.87 years which was greater than what was observed by Dubey P et al (44.4 years) and much higher compared to Musheer Ahmed M et al.[84,88]

Gender

In the present comparison, male predominance is seen in most studies, such as Parate R et al. (2025) and Bansal A et al. (2018), reporting M:F ratios of 2.39:1 and 2.53:1, respectively.[83] This pattern is commonly attributed to a higher incidence of urolithiasis, smoking-related urothelial pathology, and occupational exposures among men, all of which increase the likelihood of evaluating hematuria with advanced cross-sectional imaging. Similarly, Dubey P et al. (2025) noted only a slight male predominance (1.14:1), suggesting that while men continue to represent a larger proportion of evaluated cases, the gender gap is narrowing in some populations.[84] On the contrary, Geetanjali YS et al. (2025) reported a female predominance (M:F = 0.56:1).[82] Such findings may be explained by differences in referral patterns and etiologies, including urinary tract infections and inflammatory causes that more commonly affect women.

Overall, these observations highlight that sex-related trends influence the spectrum of MDCTU findings, but the modality remains equally important in both sexes. In men, its role is often oriented toward detecting urolithiasis and urothelial carcinoma, whereas in women it assists in clarifying non-specific hematuria where ultrasound may be inconclusive.

Clinical Pattern of Hematuria

In the present study, macroscopic haematuria constituted the majority of cases (60%), while microscopic haematuria accounted for 40%. This distribution is comparable to the findings of Dubey et al. (57% macroscopic, 43% microscopic), suggesting that visible haematuria continues to be the more frequent presentation prompting clinical evaluation and referral for advanced imaging[84]. Tyagi et al. demonstrated an even higher proportion of macroscopic haematuria (83.87%).[80] The predominance of macroscopic presentation in this study suggests appropriate referral bias toward clinically alarming cases.

However, studies such as Bansal et al. reported a slightly higher proportion of microscopic haematuria (53.33%), possibly reflecting differences in case selection, increased screening, and wider use of routine urinalysis in asymptomatic patients.[91]

In the present study, painless haematuria was observed in 66.67% of patients, while 33.33% presented with painful haematuria. This pattern is consistent with findings from Thakur et al. (64% painless) and Dubey et al. (62% painless), indicating that painless haematuria remains the predominant clinical presentation among patients undergoing MDCTU evaluation.[81,84] Similarly, Bansal et al. reported 63.33% painless haematuria, while Kumar et al. noted an even higher proportion (72%).[91,92] The predominance of painless haematuria across these studies highlights its strong association with significant underlying pathology, particularly urothelial and renal malignancies, which typically present without accompanying pain until advanced stages.

Painful haematuria, although less frequent, still accounted for one-third of our cases and showed comparable proportions across previous studies (28–38%). This observation is of considerable clinical importance, as painless hematuria is classically associated with urothelial carcinoma. In such scenarios, MDCTU plays a crucial role by not only identifying the source of bleeding but also delineating associated complications such as obstruction, hydronephrosis, and perinephric inflammatory changes.

In the present study, abdominal pain was the most common presenting complaint, reported in 72.38% of patients. This finding is consistent with observations by Thakur MS et al., who reported abdominal pain in 56% of cases, and Kumar R et al., where 48% of patients presented with similar symptoms.[81,92] Bansal A et al. documented a higher prevalence of abdominal pain (80%), possibly reflecting a greater proportion of obstructive or inflammatory pathologies in their study population.[91] The variation in frequency across studies may be attributed to differences in referral patterns, disease spectrum, and institutional protocols.

Abdominal pain, observed in 72.38% of patients, further reflects the high burden of obstructive calculous pathology in the studied population.

Histopathological Correlation and Disease Spectrum

Histopathological correlation was available in 94 patients and revealed calculi (47.87%) as the most common etiology, followed by bladder carcinoma (25.53%) and renal carcinoma (14.89%).

The predominance of calculi mirrors the known epidemiological pattern in the Indian subcontinent, where climatic conditions, dietary habits, and hydration status contribute significantly to stone disease.

Among malignancies:

- Transitional cell carcinoma was the most common bladder malignancy
- Clear cell carcinoma predominated among renal cancers.

These distributions are consistent with global oncological data and validate the representativeness of the study population.

Importantly, MDCTU findings demonstrated strong concordance with histopathological outcomes, highlighting its high diagnostic accuracy and reliability in characterizing both benign and malignant pathologies.

In the present study, the most common ultrasonography (USG) finding was hyperdense ureteric calculus with upstream hydroureteronephrosis, observed in 21.90% of patients. This reflects the predominance of obstructive urolithiasis as a cause of haematuria in our study population. Similar findings have been reported by Parate R et al., who identified urolithiasis as the most frequent USG abnormality, emphasizing the utility of USG as an initial screening modality for detecting calculous disease.[83]

In contrast, Thakur MS et al. reported positive USG findings in 62.4% of cases, with bladder cancer being the most common diagnosis (18.4%), while Kumar R et al. observed bladder carcinoma in 18% of patients.[81,92] Irregular echogenic intravesical mass was observed in 22 (20.95%) which indicates bladder carcinoma was our second frequent findings on USG and its proportion was slightly higher than Kumar R et al's study.[92]

Comparative Imaging Evaluation: USG versus MDCTU

Ultrasonography served as an initial screening tool and detected ureteric calculi and intravesical masses in a considerable number of cases. However, several limitations were evident:

- Reduced sensitivity for small ureteric calculi
- Limited ability to characterize enhancement patterns
- Inability to stage malignancy
- Operator dependence

MDCTU, on the other hand, demonstrated superior diagnostic capability by:

- Detecting hyperdense calculi with precise localization
- Demonstrating enhancing bladder wall masses with perivesical fat invasion
- Characterizing renal masses with necrosis and calcification
- Assessing obstruction severity
- Providing multiplanar and 3D reconstructions
- Facilitating tumor staging

MDCTU effectively functioned as a comprehensive "one-stop" imaging modality, simultaneously evaluating renal parenchyma, collecting systems, ureters, and bladder within a single examination.

In the present study, nephrolithiasis was the most common final clinical diagnosis, accounting for 24.76% of cases. This finding is comparable with studies by Parate R et al. and Bansal A et al., where urolithiasis was the predominant diagnosis, reported in 36% and 41.67% of patients respectively.[83,91] The high prevalence of stone disease across these studies reflects the significant burden of urolithiasis in the Indian population, likely influenced by climatic factors, dietary habits, inadequate hydration, and metabolic predispositions.

In contrast, Thakur MS et al. reported bladder carcinoma as the most common diagnosis (18.4%), while Kumar R et al. found transitional cell carcinoma in 20% of their study population.[81,92] Our study found bladder carcinoma to be the second common diagnosis among 24 (22.86%) patients, which was similar to prevalence by Kumar R et al.[92]

Thakur MS et al and Parate R et al each found 1-2 cases of BPH and prostate carcinoma, however, in contradiction to this, we found no such cases.[81,83]

Clinical Significance of MDCTU

The present study reaffirms several important clinical implications:

1. Painless hematuria in elderly patients warrants thorough malignancy exclusion.

2. MDCTU provides high-resolution anatomical detail that directly influences surgical planning and staging.

3. It enables early detection of malignancy before symptomatic progression.

4. It identifies incidental but clinically relevant findings, thereby improving overall patient care.

5. It demonstrates strong histopathological concordance.

The ability of MDCTU to characterize enhancement patterns and detect subtle urothelial lesions makes it superior to conventional imaging modalities in hematuria evaluation.

Future multicentric studies with larger sample sizes and long-term follow-up would further validate these findings. Additionally, evaluation of low-dose CT protocols may help balance diagnostic accuracy with radiation safety.

SUMMARY

This longitudinal study evaluated the role of Multidetector Computed Tomography Urography in 105 patients presenting with hematuria at a tertiary care hospital.

Key findings include:

- Predominance in older adults (peak 61–70 years)
- Male preponderance (M:F = 2.39:1)
- Majority presenting with macroscopic and painless hematuria
- Calculi as the most common histopathological finding
- Bladder carcinoma as the second most common diagnosis
- Strong correlation between MDCTU findings and final clinical diagnosis

MDCTU most frequently demonstrated:

- Hyperdense calculi with obstructio
- Enhancing bladder wall masses
- Heterogeneously enhancing renal masses

CONCLUSION

The present study conclusively demonstrates that Multidetector Computed Tomography Urography is a highly accurate, comprehensive, and clinically indispensable imaging modality in the evaluation of hematuria.

While urolithiasis remains the most common etiology, a substantial proportion of patients harbor malignant pathology, particularly bladder carcinoma. The high incidence of painless hematuria associated with malignancy further emphasizes the need for thorough imaging evaluation.

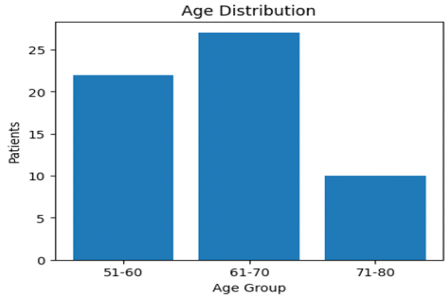
MDCTU surpasses ultrasonography in diagnostic precision by:

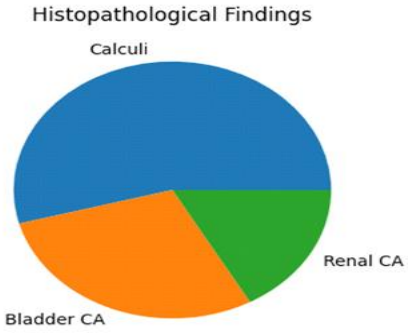
- Accurately detecting calculi
- Characterizing renal and urothelial masses
- Assessing tumor invasion and staging
- Demonstrating obstruction and complications
- Providing multiplanar and 3D visualization

Given its ability to evaluate the entire urinary tract in a single examination, MDCTU can be regarded as the imaging modality of choice in patients presenting with hematuria, particularly in individuals above 40 years of age and those with painless hematuria.

In conclusion, MDCTU serves as a definitive "one-stop" diagnostic tool that facilitates early detection, accurate characterization, optimal treatment planning, and improved prognostic outcomes in patients with hematuria.

Diagrams and Graphs





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