Role of multidetector CT Urography in patients with hematuria

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ABSTRACT

Introduction: With the advancement in imaging abilities like thin slicing, volume rendering and 3D reconstruction, multidetector CT urography has been a preferred over other imaging modalities for the comprehensive assessment of kidney, ureter and bladder. Hematuria is one of the commonly encountered complaints of patients in hospital. The aim of our study was to evaluate the role of multidetector computer tomographic urography in hematuria and guiding the clinician to find cause and manage it. **Methods:** A hospital based prospective cross-sectional study conducted among 228 patients who presented with either gross or microscopic hematuria. Data collected were analyzed using Statistical Package for Social Sciences version 26.0. **Results:** Patients commonly presented with gross hematuria 148(64.91%) with commonest cause being urolithiasis, 103 patients. Calculus predominantly involved kidney 66(28.94%) followed by kidney and ureter 14(6.14%). Hydronephrosis and hydroureteronephrosis were seen in 87(38.14%) and 35(15.36%) patients, respectively. Normal excretion was observed in majority patients 202(88.60%). Pyelonephritis 17(7.46%) and cystitis 11(4.82%) were the common infections noted. Among the identified masses, kidney was the commonest site of origin 52(22.84%), followed by bladder 10(4.82%) and the ureter 4(1.75%). Kidney masses were predominantly non-malignant. Ureter masses were rare but all detected lesions were malignant 4(1.75%), Bladder masses were also infrequent; however, a relatively higher proportion were malignant 8(3.50%) compared to kidney findings. Incidental findings included spectrum of diseases and disorders that included anatomical variants, lesions in other sites and congenital defects. **Conclusions:** With the findings from our study, we can conclude that MDCT Urography is found to be highly accurate in detecting the causes of hematuria and guide the clinician in timely management. It is also useful in detection of other associated and incidental findings which might not have been detected in clinical evaluation but have significant role in patient care.

Keywords: Hematuria, multidetector computed tomography, urography.

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INTRODUCTION

Hematuria, presence of blood in urine, can be either macroscopic that can be grossly visible or microscopic that can be seen only under microscopic. Microhematuria are often asymptomatic and has a prevalence of 4–5% in routine clinical practice.[1-4] 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. In either form, it can sometimes be the only clue to serious urological conditions including malignancy. Gross hematuria clearly conveys a much higher risk of malignancy than microscopic disease and should be thoroughly evaluated,[5,6] but virtually all cases of hematuria as defined by AUA guidelines need a complete work-up.

Multidetector computed tomography (MDCT) urography (MDCTU) has replaced excretory urography as the first imaging test in many institutions. MDCT is less susceptible to overlying bowel gas and more

sensitive for detection of small tumors and calculi because of its ability to acquire thinly collimated data sets which can be used to create excellent 3D quality images of the urinary tract.[7] Single breath-hold coverage of the entire urinary tract with absence of respiratory mis-registration, rapid imaging with optimum contrast medium opacification and reduced partial-volume effect as appropriate slices can be selected from the volumetric data. These advantages have established MDCTU as a compelling alternative to excretory urography and ultrasonography (US) in the evaluation of the patient with hematuria.[8,9]

The objective of this article was to discuss the role MDCTU in finding cause of hematuria that could aid in guiding the management procedure to the clinicians by detecting the accurate cause.

METHODS

This was a hospital based prospective cross-sectional study conducted Department of Radiology and Imaging in Gandaki Medical College & Teaching Hospital, Pokhara, Nepal for a duration of one year from June 1, 2021 to May 31, 2022. Ethical approval was obtained from Institutional Review Committee of Gandaki Medical College. (Ref. No. 003/2078/2079)

The sample size was calculated using formula: $n=z^2 \times p(1- p)/d^2$ where, Z=1.96 (normal standard distribution at confidence level 95%), p(expected true proportion) =50% (0.5), d(margin of error) =(0.05) done by simple random sampling technique. Total 228 patients who presented clinically with gross/microscopic hematuria, underwent ultrasonography and further advised for MDCTU were enrolled in the study. The lab reports were collected from Department of Clinical Biochemistry for gross and microscopic hematuria. The written consent was obtained from all the patients. Patients having calculi were diagnosed according to their Hounsfield Unit (HU) values, infections and malignancies from their pre and post contrast evaluation with enhancement pattern and excretory functions from excretory phase evaluation.

All the patients above 14 years presenting with hematuria were included. Patients diagnosed during pregnancy and lactation or with cardiac failure, deranged renal function test, multiple myeloma, with established diagnosis for hematuria and those allergic to contrast medium were excluded from the study.

Procedure of CT urography

The data were collected from the workstation of CT scan through VITERIA, provided by Canon S. Prime 128 slice CT scanner. CT scan was performed in low dose, 100 kVp and 300 mAs. Plain CT KUB was taken from dome of diaphragm to below pubis symphysis caudally. Image was viewed by reporting radiologist. Then intravenous contrast was given by single injector at a rate of 3-4 ml/s as 1 ml/kg. Second phase was arterial/ corticomedullary phase at 35 to 45 seconds after the contrast administration. Third phase was venous/nephrographic phase at 120 seconds. Finally delayed phase was taken ten minutes with further additional films if the situation required. Images were reconstructed. After that, kidneys, ureters and bladder were assessed for cause as well as other incidental findings.

The data were entered in the Statistical Package for Social Sciences (SPSS) version 26.0. Categorical variables were summarized using frequency and percentage, while numerical data were presented as mean±standard deviation.

RESULTS

Out of 228 patients evaluated, 133(58.30%) were males. The mean age of patients was 48.3±19.2 years with majority 61(26.8%) in 31 to 45 years age groups. Patients' commonly presented with gross hematuria 148(64.91%) and 80(35.09%) patients exhibited microscopic hematuria. 95(41.66%) patients didn't have any significant findings in MDCTU.

Single calculus was seen in 50(21.92%) and multiple calculi were seen in 53(23.24%) patients, indicating urolithiasis as the most common cause of hematuria. Calculus was found predominantly in kidney 66(28.94%) followed by kidney and ureter 14(6.14%). Right kidney involvement 43(18.85%) was commonly observed. (Table 1)

Table 1: Calculus findings among study patients (n=228)

Calculus Findings	Frequency(n)	Percentage(%)
Number		
Absent	125	54.82%
Single	50	21.92%
Multiple	53	23.24%
HU		
Absent	125	54.82%
≥600	33	14.47%
<600	59	25.87%
Both	11	4.82%
Side		
Absent	125	54.82%
Right	43	18.85%
Left	30	13.15%
Both	30	13.15%
Site		
Absent	125	54.82%
Kidney	66	28.94%
Ureter	22	9.64%
Bladder	1	0.43%
Kidney and Ureter	14	6.14%

Hydronephrosis was seen in 87(38.14%) patients, while hydroureteronephrosis was seen in 35(15.36%) patients. Normal excretion was observed in 202(88.60%) patients whereas both delayed and non-excretion was seen in 13(5.70%) patients. (Table 2)

Table 2: Status of parameters among study patients (n=228)

Parameters	Frequency(n)	Percentage(%)
Hydronephrosis		
Absent	141	61.84%
Present	87	38.15%
Hydroureteronephrosis		
Absent	193	84.64%
Present	35	15.36%
Excretion		
Normal	202	88.60%
No-Excretion	13	5.70%
Delayed Excretion	13	5.70%

Majority of the participants 194(85.09%) did not show any infection. In patients exhibiting infection, common occurrence were found to be pyelonephritis 17(7.46%) followed by and cystitis 11(4.82%). (Table 3)

Table 3: Types of infection among the study participants (n=228)

Infection	Frequency(n)	Percentage(%)
No Infection	194	85.09%
Chronic Pyelonephritis	2	0.88%
Cystitis	11	4.82%
Distal Ureteritis	1	0.44%
Emphysematous Pyelonephritis with Cystitis	2	0.88%
Pyelitis with Ureteritis	1	0.44%
Pyelonephritis	17	7.46%

In the present study, the majority of participants 162(71.05%) did not have any detectable masses. Among the identified masses, the kidney was the most common site of origin 52(22.84%), followed by the bladder 10(4.82%) and the ureter 4(1.75%). Kidney masses were predominantly non-malignant, with benign 34(14.91%) and intermediate 13(5.77%) lesions comprising the majority, while malignant kidney masses were uncommon 5(2.12%). Ureter masses were rare but all detected lesions were malignant 4(1.75%), although the small sample size limits interpretation. Bladder masses were also infrequent; however, a relatively higher proportion were malignant 8(3.50%) compared to kidney findings. Overall, masses were uncommon in this study population, and malignant lesions constituted only a small fraction of all abnormalities detected. (Table 4)

Table 4: Origin and nature of mass among the study participants (n=228)

		Mass of Origin		
Nature of mass	Absent	Kidney	Ureter	Bladder
Benign	-	34(14.91%)	0	2(0.87%)
Intermediate	-	13(5.77%)	0	0
Malignant	-	5(2.12%)	4(1.75%)	8(3.50%)
Total n(%)	162(71.05%)	52(22.84%)	4(1.75%)	10(4.82%)

Incidental findings included spectrum of diseases and disorders that included anatomical variants, lesions in other sites and congenital defects. One of the significant findings were partial PUJ obstruction in 5(2.19%) patients without clinical symptoms or signs. A small proportion showed urological variations or abnormalities, including malignant sacrococcygeal mass 1(0.43%), retroperitoneal lymphoma 1(0.43%), malignant pancreatic mass 1(0.43%), adrenal tumour 1(0.43%) that required immediate intervention whereas non-urological findings for surgical intervention like acute appendicitis 1(0.43%) and liver abscess 1(0.43%) were also diagnosed and hence treated in time. Rest of the findings were considerable while planning for treatment decisions in future. (Table 5)

Table 5: Incidental findings (n=228)

Incidental Findings	Frequency	Percentage(%)
Normal	175	76.75%
Partial PUJ Obstruction	5	2.19%
Bilateral Extrarenal Pelvis	3	1.31%
Horseshoe Kidneys	3	1.31%
Small Right Kidney	3	1.31%
Simple Hepatic Cysts	2	0.87%
Absent Left Kidney, Malignant Sacrococcygeal Mass	1	0.43%
Acute Appendicitis	1	0.43%
Angiomyolipoma In Kidney	1	0.43%
Bifid Collecting System	1	0.43%
Carcinoma Cervix	1	0.43%
Choledocholithiasis, Duplex Collecting System In Left	1	0.43%
Ectopic Right Kidney, Puj Stricture	1	0.43%
Fused Ectopic Kidneys In Suprapubic Region With Renal Arteries From Femoral Artery	1	0.43%
Giant Uterine Fibroid Compressing Left Ureter	1	0.43%
Gist, Ascending Colon	1	0.43%
Grade Iii Renal Injury, Splenic Hematoma	1	0.43%
Horse Shoe Kidneys	1	0.43%
Hydatid Cyst In Liver	1	0.43%
Left Adrenal Tumour	1	0.43%
Liver Abscess	1	0.43%
Lymphangioma Of Ascending Colon	1	0.43%
Malignant Pancreatic Mass	1	0.43%
Mesenteric And Retroperitoneal Lymphadenopathy	1	0.43%
Retroperitoneal Fibrosis	1	0.43%
Retroperitoneal Mass Obstructing Ureter likely Lymphoma	1	0.43%
Right Nephrectectomy Status	1	0.43%
Right Ureterocele	1	0.43%
Tubercular Abdomen	1	0.43%
Umbilical Hernia	1	0.43%
Uterine Fibroids	1	0.43%

DISCUSSION

CT urography provides a detailed anatomic depiction of each of the major portions of the urinary tract—the kidneys, intrarenal collecting systems, ureters, and bladder—and thus allows patients with hematuria to be evaluated comprehensively.[10] Hematuria can be due to spectrum of causes ranging from calculi and infections to malignancies. Hence, early and accurate diagnosis of etiological factor helps in early and effective management.

In our study, most commonly involved patients were from 31 to 45 age groups with male predominance. These findings align with the results of a study by Song et al.[11] These data interpret the working age group male predominantly suffer hematuria, predominantly suffering from renal calculi might be due to lack of adequate water intake or environmental factors.

In this study, urolithiasis was found to be the most common cause of hematuria. This is in correspondence with the study done by Ghous et al.[12] and Yadav et al.[13] Renal involvement for urolithiasis was commonest in both the studies.

In a study done by Bretlau et al., no abnormalities were found at CT urography in 58% of the patients with hematuria. Lesions were found more frequently in patients with visible hematuria than in patients with non-visible hematuria.[14] In this study, 95(41.66%) patients too didn't have any significant findings in MDCTU. This implies that hematuria not always have urinary tract abnormalities in CT imaging however they should regularly be followed up.

Calculi were commonly located in kidney, either right or left or both (64.07% of all KUB calculi). Danjem et al. also concluded kidney stones are the most common followed by the ureter, the pelvi-ureteric junction, the vesico-ureteric junction and the bladder.[15] This is indeed important to precisely locate the calculi so that the urosurgeons can plan their future procedures for the treatment.

This study also evaluated the excretory function in all the patients with hematuria where 13(5.7%) each of the patients either had non excretion or delayed excretion. In a study done by Pokhrel et al., they evaluated the role of CT urography in obstructive uropathy and found to be very accurate in findings the level of obstruction.[16]

Fourteen percent of total patients had findings of infection in urinary tract, predominantly pyelonephritis (50%) aligning with the findings of Ghous et al.[12] Among 10 of the detected bladder masses in our study, eight were found to be malignant. In a study done by Sadow et al., they have stated that CT urography is an accurate non-invasive test for detecting bladder cancer in patients at risk for the disease. The high NPV of CT urography in patients with hematuria may obviate cystoscopy in selected patients.[17] We had followed all the eight cases which were found to be malignant in histopathological report.

About 34(14.91%) of the total 52 detected renal masses were found to have benign characteristics. Wide spectrum of incidental findings were detected while evaluating for hematuria, some of them warranting immediate medical intervention. In a study done by Liu et al, they stated although incidental extraurinary findings were common at MDCT urography, only a small percentage of patients were imaged further. MDCT urography, when used to evaluate patients with hematuria, detects extraurinary disease without a substantial increase in per-patient imaging costs.[18]

The wide spectrum of incidental findings during our study has raised the utility of MDCTU apart of only evaluating the urological findings. The findings like malignancies and acute abdominal conditions like acute appendicitis and liver abscess needed immediate intervention whereas other findings like ectopic kidneys or partial PUJ obstruction provided extra knowledge in planning for future diagnosis.

Contrast enhanced CT urography procedure exposes patients to high doses of ionizing radiation; hence, justification and optimization of doses are necessary to maximize the benefits and minimize the patients' risks. Low dose radiation exposure and risk and cost benefit evaluation have been done in utmost possible way in our study. Single-centred design, lack of cystoscopy correlation in all cases, and no follow-up in non-mass cases may limit generalizability and accuracy estimates.

CONCLUSIONS

With the technological advancement in imaging technique like multidetector CT urography, it has resulted in the ability to image the urinary tract in ways that surpass the prior mainstay of urinary tract imaging. It provides elaborated diagnostic information hence is the test of choice for evaluation of patients presenting with either form of hematuria. Since a wide spectrum of causes are seen in hematuria, clinicians should consider MDCTU to patients for evaluation whenever clinically indicated.

CONFLICTS OF INTEREST: None declared

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AUTHORS' CONTRIBUTIONS

The concept was designed by SP; the literature search was conducted by SP and YNR, data were collected by BRS, PS, NP; data analysis was performed by SP and KS; all authors contributed to drafting the manuscript and approved the final version, taking full responsibility for its content.

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