A DESCRIPTIVE CROSS-SECTIONAL STUDY OF URINARY TRACT ABNORMALITIES UTILIZING MULTI-DETECTOR COMPUTED TOMOGRAPHY UROGRAPHY

Subhash Chandra Yadav,[1] Sanju Rawal,[1] Sadhan Mukhi,[1] Darshana Dhakal[1]

ABSTRACT

INTRODUCTION

Multidetector Computed Tomography Urography (MDCTU) is presently considered the preferred imaging modality for the urinary tract. Advanced MDCTU enables a comprehensive assessment of the kidneys, ureters and urinary bladder. MDCTU is commonly employed to investigate various conditions such as renal calculi, renal cysts, congenital kidney and ureter abnormalities, and specific renal inflammatory conditions. The objective of this study was to evaluate the diagnosis of various urinary tract abnormalities using MDCTU.

MATERIAL AND METHODS

This descriptive cross-sectional study was conducted from June to August 2023, at the Department of Radiodiagnosis & Medical Imaging, Universal College of Medical Sciences and Teaching Hospital, Bhairahawa, Nepal, examined a total of fifty-nine patients. The examination protocol comprised triphasic techniques, which included unenhanced, nephrographic, and excretory phases, utilizing a MDCT scanner. The descriptive data were analyzed using SPSS version 20 and presented in the form of a number and percentage.

RESULTS

A total 59 patients, 32 were male and 27 were female. Mean age of patients were 44.17±15.66 years, with the majority (28.81%) falling within the age range of 20-30 years. Abdominal pain was the most common symptom (79.66%), followed by hematuria (18.64%). Urolithiasis was the most frequent diagnosis (47.46%), followed by ureterohydronephrosis (22.03%) and hydronephrosis (18.64%). Inflammatory change/infection affected 13.56% of patients, while congenital abnormalities were the least prevalent (3.39%).

CONCLUSION

MDCT urography is considered the optimal modality for detecting a broad range of urinary tract abnormalities, due to its utilization of a combination of unenhanced, nephrographic-phase, and excretory-phase imaging techniques.

KEYWORDS

MDCT, Urography, Urinary tract abnormalities

1. Department of Radiodiagnosis and Medical Imaging, Universal College of Medical Sciences & Teaching Hospital, Bhairahawa, Nepal

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For Correspondence
Subhash Chandra Yadav
Department of Radiodiagnosis and Medical Imaging
Universal College of Medical Sciences
Bhairahawa, Nepal
Email: subhashyadav696@gmail.com

INTRODUCTION

Multi-detector computed tomography urography (MDCTU), also referred to as CT urography, has emerged as the preferred imaging modality for comprehensive assessment of the urinary tract.[1] It is a non-invasive procedure providing high-resolution, multi-planar images of the kidneys, ureters, and urinary bladder that allow for identification and diagnosis of various urinary tract disorders.[2,3] This imaging method is the precise and effective diagnostic tool for identifying structure abnormalities, stones or tumors as well as pathological conditions of the urinary tract.[4] It has several advantages, including the absence of respiratory mis-registration, rapid imaging with optimal contrast medium pacification, reduced partial-volume effect because appropriate slices can be selected from volumetric data, and acquisition of multiple thin overlapping slices providing excellent two- and three-dimensional reformations. These advantages make CTU a compelling alternative to excretory urography (EU) and ultrasonography (US).[5-7] The objective of this study was to evaluate the diagnosis of various urinary tract abnormalities using MDCTU.

MATERIAL AND METHODS

A descriptive cross-section study was conducted from June 2023 to August 2023 at the Department of Radiodiagnosis and Medical Imaging, Universal College of Medical Sciences and Teaching Hospital, Bhairahawa, Rupandehi, Nepal. The study was approved by the Institutional Review Committee of UCMS-TH (UCMS/IRC/019/23), and informed consent was obtained from all patients. The study enrolled a total of 59 patients who were referred to the department with suspected urinary tract abnormalities for CTU scans. The sample size was calculated using cohort formula: $n=z^2p(1-p)/d^2$, where n represents the required sample size, z represents the confidence level at 95%, P represents 96% of the prevalence of Urinary tract abnormalities detection[7] and d represents the allowed error at 5%.

The sample size was estimated to be 59.

Inclusion criteria: Patients with suspected

- Urinary tract calculi or infections
- Renal parenchymal masses
- Collecting system abnormalities
- Congenital anomalies of kidneys and ureters
- Renal cystic diseases
- Diseases of the urinary bladder

Exclusion Criteria:

- Patients who are below 18 or above 80 years of age
- Pregnant women
- Patients with renal failure
- Patients with cardiac failure
- Those with a known allergy to contrast media

Multi-Detector Computed Tomographic Urography: An Imaging Technique

MDCT urography was conducted utilizing a 16-slice CT scanner of the GE Brivo Model. The procedure employed a three-phase technique, comprising of an unenhanced phase, a nephrographic phase, and an excretory phase. All patients were orally administered with 400-500 mL of water 20 minutes prior to the examination. The initial unenhanced phase was obtained from the upper pole of kidney to the symphysis pubis using a 5-mm collimation and 1.2 mm reconstruction interval. This was done to evaluate the size of the kidneys, areas of abnormal density (such as hemorrhage, calcifications, stones, gas, masses, and abnormal fluid collection), and perinephric stranding. The nephrographic phase was obtained utilizing a 5 mm collimation and 1.0 mm reconstruction interval, precisely 100 seconds after the administration of 80-100 mL of iodinated contrast agent (Ultravist 300 mgI/mL) at a rate of 3 to 4 mL/s, using a power injector with a 15 to 25 second delay or a Smart Prep Sequence (IMAXEON SSHM1516C DC022). The purpose of this phase was to assess the renal parenchymal infection and its current extent. The final acquisition was obtained with a collimation of 5 mm and reconstruction interval 1.25 mm during the excretory phase after a delay of 8 to 10 minutes. Throughout this phase, there was noted opacification and distension of the collecting systems, ureters, and bladder. The scanning parameter for each phase was set at 120 kV, 90-180 mA of tube current, utilizing current modulation software, with a collimation of 5 mm and a pitch of 1.375:1. The acquisition time was between 18 to 24 seconds per scan. The scan parameters for MDCTU have been concisely outlined in Table 1. 3D reconstructions of the unenhanced, nephrographic and excretory phases were carried out as well as when necessary.

Table 1. Scanning parameters utilized in the routine multi-detector computed tomography urography (MDCTU) protocol

Scanning parameters	Value
Tube Voltage (kV)	120
Tube Current (mA)	90-180
Gantry rotation time	0.6 sec
Beam Pitch	1.375:1
Beam collimation	5 mm
Slice thickness (routine study)	5 mm (full width at half maximum)
Slice thickness (for renal mass)	5 mm (full width at half maximum)
Reconstruction interval	1.0-1.25 mm

The data were presented as mean±standard deviation (SD), whereas categorical data were expressed as frequency and percentages (%). The Statistical Package for the Social Sciences (SPSS) software, version 20, was used to analyze the data. Additionally, Microsoft Word and Excel were used to generate the table.

RESULTS

The present study comprised a total of 59 patients, consisting of 32 males and 27 females. The mean age of the patients was 44.17±15.66 years, with the age range spanning from 20 to 72 years. The highest frequency of patients was observed in the 20-30 years age group, with a total of 17 patients (28.81%), followed by the 51-60 years age group with 13 patients (22.03%). The age groups ranging from 71 to 80 years had the lowest number of patients, with only 2 patients (3.4%). Among the 59 patients, multiple clinical symptoms were observed. Specifically, 47 patients (79.66%) reported having abdominal pain, 11 patients (18.64%) had hematuria, 9 patients (15.25%) exhibited fever, 6 patients (10.17%) had weight loss and 4 patients (6.78%) had loss of appetite (Table 2).

Table 2. Demographic characteristics of the patients, n = 59

Characteristics	Frequency	Percentage
Gender		
Male	32	54.24
Female	27	45.76
Age (years)		
20-30	17	28.81
31-40	10	16.95
41-50	7	11.86
51-60	13	22.03
61-70	10	16.95
71-80	2	3.4
Mean age±SD = 44.17±15.66		
Clinical Symptoms		
Abdominal Pain	47	79.66
Hematuria	11	18.64
Fever	9	15.25
Loss of Weight	6	10.17
Loss of Appetite	4	6.78

Table 3. Presents the urinary tract lesions that have been identified through the use of MDCTU, n=59

Lesions	Frequency	Percentage
Urolithiasis encompasses the right and left kidney/pelvi-ureteric junction/ureter/ vesico-ureteric junction and bladder.	28	47.46
Hydronephrosis	11	18.64
Ureterohydronephrosis	13	22.03
Renal parenchymal masses/cysts	9	15.25
Inflammatory change/infection	8	13.56
Renal trauma	4	6.78
Congenital anomalies	2	3.39
Presence of calculi (n=28)		
Right side of urinary tract	13	46.43
Left side of urinary tract	9	32.14
Bladder	6	21.43
Location of calculi within the urinary tract		
Right side of urinary tract, n=13		
Renal calyces	4	30.7
Renal pelvis/PUJ	3	23.1
Proximal ureter	2	15.4
Distal ureter	2	15.4
Vesico-ureteric Junction	2	15.4
Left side of urinary tract, n=9		
Renal calyces	5	55.6
Renal pelvis/PUJ	1	11.1
Proximal ureter	1	11.1
Distal ureter	1	11.1
Vesico-ureteric Junction	1	11.1

According to Table 3, Urolithiasis was identified in 28 out of 59 patients (47.46%), making it the most prevalent pathology that was diagnosed. Calculi were observed in 46.43% of patients on the right side (kidney/pelvi ureteric junction/ureter/vesico-ureteric junction) and in 9 patients (32.14%) on the left side (kidney/pelvi ureteric junction/ureter/vesico-ureteric junction). Six patients (21.43%) were diagnosed with calculi in the bladder. Additionally, 22.03% of patients had hydronephrosis and 15.25% had renal parenchymal masses/cysts.

Overall, Multi-Detector Computed Tomography Urography (MDCTU) was conducted on 59 cases, yielding significant insights into urinary tract abnormalities. Figure 1-a, b and c show the different lesions identified in 59 patients.

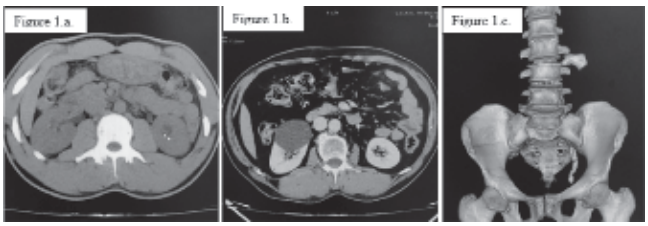

Figure 1a shows renal calculi; 1b shows renal cysts; and 1c displays 3D image with multiple calculi

DISCUSSION

Our study comprised of 59 patients who exhibited strong indications of urinary tract abnormalities. Triphasic MDCT urography was conducted, encompassing an unenhanced phase, nephrographic phase, and excretory phase. The unenhanced phase was generated from the upper pole of the kidney to the symphysis pubis. Intravenous contrast media was administered, and subsequent to a nephrographic phase of 100 seconds, the abdomen and pelvis were scanned. The ultimate acquisition was during the excretory phase, following a delay of 8-10 minutes.

Urinary tract abnormalities have been categorized into several distinct types, including urolithiasis, renal parenchymal masses/cysts, inflammatory changes, congenital anomalies, and bladder pathology. Furthermore, secondary signs were observed, such as hydronephrosis, ureterohydronephrosis, and delayed renal excretion. Clinical observations have been made as to clinical characteristics, including Abdominal Pain, fever, weight loss and hematuria.

In this study, the mean age of the patients was 44.17±15.66 years, which is consistent with the results reported by Shankar KR et al and Gupta R et al, where the mean age of the patients was 41.84±16 years and 44 years, respectively.[7,8] The present study comprised of 32 male (54.24%) and 27 female (45.76%), a distribution that is comparable to the research conducted by Mahmoud MA et al, Panchmahalkar AC et al, and Gupta R et al,[4,6,8] where the male and female proportions were 40%, 58%, 68.33% and 60%, 42%, 31.66%, respectively.

We have observed an age distribution of between 20 and 72 years in our study. Most patients were in the age range of 20 to 30 years, making up 28.81% of the sample. Twenty years of age was the younger patient, whereas the oldest was aged 72. We have found that our findings are slightly less than that previous studies performed by Kumar R et al, Mahmoud MA et al, Panchmahalkar AC et al,[2,4,6] where the majority of patients (25%-30%) fall within the age range of 51-60 years.

In the present study, urolithiasis was identified as the most prevalent renal tract abnormality, affecting 28 patients (47.46%). This percentage is notably higher than the findings reported by Lin WC et al,[9] where urolithiasis was diagnosed in 39.22% of patients. Conversely, Caoili EM et al[10] reported a significantly lower incidence of urolithiasis, affecting only 7.7% of patients. Rathi V et al[11] identified urolithiasis in 25.7% of patients, while Anjum M et al,[12] reported the lowest incidence of renal calculi, affecting only 9% of patients. There may be a difference due to different age groups.

In this study, the diagnosis of hydronephrosis was recognized in 11 patients (18.64%), a lower incidence compared to the research conducted by Anjum M et al,[12] where hydronephrosis was 27%. Renal parenchymal masses or cysts were identified in 9 patients (15.25%), a slightly higher occurrence than that reported in a published study by ShanKaR KR et al,[7] where 14% of renal masses or cysts were observed. The least prevalent abnormality in our study was congenital anomaly, with a frequency of 3.39%, which was consistent with the findings of a previous study conducted by Lin WC et al,[9] where a frequency of 3.92% was observed. There could be a difference due to differences in ages, regions, and places of residence. Another significant factor is the different parameters used in the analysis.

CONCLUSION

In this study, MDCTU was found to be a valuable tool in the detection of urinary tract abnormalities. Urolithiasis was the most frequently detected pathology, followed by ureterohydronephrosis and renal cysts. Congenital anomalies were detected in a small proportion of cases. MDCTU should be considered as an initial diagnostic tool in patients with suspected urinary tract abnormalities. Further studies are needed to evaluate the long-term outcomes of patients with MDCTU-detected urinary tract abnormalities.

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CONFLICT OF INTEREST

None

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