|| Print ISSN: 2589-7837 || Online ISSN: 2581-3935 ||
International Journal of Medical Science and Diagnosis Research (IJMSDR)
Available Online at www.ijmsdr.com
NLM (National Library of Medicine ID: 101738824)
Volume 7, Issue 02; March-April: 2023; Page No. 22-34

Original Research Article

Study on Ureteric Abnormalities in Single Contrast Bolus CT Urography at A Tertiary Care Centre

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Received: 19-01-2023 / Revised: 08-02-2023 / Accepted: 24-02-2023
Conflicts of Interest: Nil
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DOI: https://doi.org/10.32553/ijmsdr.v7i2.973

Abstract:

Introduction: CT urography is an imaging technique in which the i.v contrast is injected and phases of CT scan are taken to study the entire urinary system. It has essentially replaced intravenous urography (IVU) in most imaging practices. CT Urography has evolved as an ideal imaging tool for comprehensive imaging assessment of patients with flank pain, malignancies, hematuria, trauma, renal calculi, suspected congenital malformations and in various clinical settings. Other CT advantages include the use of multiplanar reconstruction (MPR), curved planar reformatted images, maximum intensity projection (MIP) and three-dimensional (3D) reconstruction which gives valuable information to the clinician about the extent of the lesions and helps in management.

Aim: To study various types of ureteric abnormalities in CT Urography in various clinical presentation.

Materials and methods: This is a tertiary hospital based observational Descriptive Cross sectional study conducted on 360 patients referred for CT Urography with Clinical Signs & Symptoms of urinary tract abnormalities, having ureteric imaging abnormalities. Siemens somatum High Definition 128 slice CT scanner was used for single bolus CT urography.

Results: Males were more as compared to females with age group 31 to 50 years (44.4%). Abdominal pain with urinary complaints was seen in maximum number of patients (203 cases-56.4%). Urinary complaints in known abdomino-pelvic malignancies was seen in 18% cases. 285 patients had obstructive urography findings like hydronephrosis or hydroureter, and 75 cases had non obstructive findings like ureteral filling defects due to calculi, clots, etc or abnormal ureteric course or only congenital abnormality. Most hydroureter cases were secondary to obstructive calculus followed by obstruction by external malignant mass.

Conclusion: This study outlines the most common ureteric abnormalities in patients referred for CT urography which were mostly obstructive findings most cases were secondary to obstructive calculus followed by obstruction by external malignant mass. The non obstructive findings like ureteral filling defects were due to calculi, clots, etc or abnormal ureteric course or only congenital abnormalities. Delayed phase of CT urography can also be applied in Contrast CT study of abdomen & Pelvic scans on case to case basis to study ureteric involvements & pathologies.

Introduction

The urinary system consists of the kidneys, ureter, bladder and urethra. With the exception of the urethra, which is same in both males and females. It spans the abdomen and pelvis, being linked with the genital system. The ureters are bilateral thin (3 to 4 mm) tubular structures that connect the kidneys to the urinary bladder, transporting urine from the renal pelvis into the bladder. The muscular layers are responsible for the peristaltic activity that the ureter uses to move the urine from the kidneys to the bladder. Embryologically, the ureter originates from the ureteric bud, which is a protrusion of the mesonephric duct, a part of the genitourinary system development. The ureters begin at the pelvi-Uretreic junction (PUJ) of the kidneys, which lie posteriorly to the renal vein and artery in the hilum.[6] The ureters then travel inferiorly inside the abdominal cavity. They pass anterior to the psoas muscle and enter the bladder on the posterior bladder aspect in the trigone. Obstruction of the urinary tract can occur in any part of the system, including the urethra, the bladder, ureters, or the renal pelvis, and depending on the duration and the specific nature of the blockage, urine may move as far up the urinary tract as the renal pelvis. The urine accumulation increases the pressure and dilates the affected regions of the renal pelvis, calyces, and ureters.[4]CT has evolved from single–detector row scanners into multi–detector row helical volumetric acquisition techniques, and these advances have made a significant impact on imaging of the urinary tract. Since CT is a cross sectional technique, overlapping structures (e.g. bowel), so long a confounding issue with intravenous urography, were not a problem with CT urography. CT urography is an imaging technique in which the i.v contrast is injected and phases of CT scan is taken to study the entire urinary system. Hence, CT Urography has evolved as an ideal imaging tool for comprehensive imaging assessment of patients with flank pain, malignancies, hematuria, trauma, renal calculi, suspected congenital malformations and in various clinical settings [1-3]. It has essentially replaced intravenous urography (IVU) in most imaging practices. Other CT advantages include the use of multiplanar reconstruction (MPR), curved planar reformatted images, maximum intensity projection (MIP) and three-dimensional (3D) reconstruction which gives valuable information to the clinician about the extent of the lesions and helps in management.

Aim:

To study various types of ureteric abnormalities in single bolus CT Urography.

Material and Methods:

Study design:

A hospital based observational Descriptive Cross sectional Study

A hospital based observational Descriptive Cross sectional study was conducted at our tertiary care centre on 360 patients to assess the various types of ureteric abnormalities in CT Urography over a duration of 18 months. The Study population were all patients referred for CT Urography imaging from clinical department with Clinical Signs and Symptoms of urinary tract abnormalities, attending OPD/IPD after due permission from the Institutional Ethics Committee and Review Board and after taking Written Informed Consent from the patients, having ureteric imaging abnormalities in CT urography. Siemens somatum High Definition 128 slice CT scanner used for performing single bolus CT urography. I.V contrast iohexol 350 mg/ml was used at dose of 1-1.5 ml/kg body weight.

Inclusion criteria:

- All patients referred for CT Urography imaging from any clinical department with Clinical Signs and Symptoms of urinary

tract abnormalities, having ureteric imaging abnormalities in CT urography on informed consent.

Exclusion criteria:

- Patients having history of allergy to contrast / Contrast hypersensitivity.
- Highly irritable patients.
- Patients having deranged KFT.
- Uncontrolled hypertension.
- Pregnancy.
- Not willing for giving consent.

CT urography is an imaging technique in which the i.v contrast is injected and phases of CT scan is taken to study the entire urinary system. In this study 128 slice Siemens CT scan is used. The technique used in our study was Single bolus CT Urography technique. Single contrast media bolus CT Urography technique is used. Patient was asked to drink 1L water before the procedure. First a non enhanced phase was taken without contrast, then I.V contrast iohexol (non ionic iodinated contrast) of 65-90 ml with concentration of 350 mg/100 ml is injected depending on the weight of the patient, then a Nephrogenic phase is taken. Excretory phase is taken 10 to 16 mins after I.V contrast, (sometimes can be delayed as per severity of obstruction). In this phase ureter is examined well to image the ureter distal to the obstruction, if an obstruction in ureter is suspected. Thus a comprehensive imaging is done and radiological findings of ureter were studied.

Safety evaluation procedure:

Pulse rate, blood pressure, respiratory rate, Oxygen saturation monitoorange during the procedure.

Adverse events such as

Sensitivity to I.V Contrast, Complications related to intravenous contrast administration were informed to patients with consent, however no such adverse events were documented in our study.

Statistical analysis –

Results were graphically represented where deemed necessary. Appropriate statistical software, including but not restricted to MS Excel, SPSS ver. 20 were used for statistical analysis. Graphical representation was done in MS Excel 2010.

Observations and Results

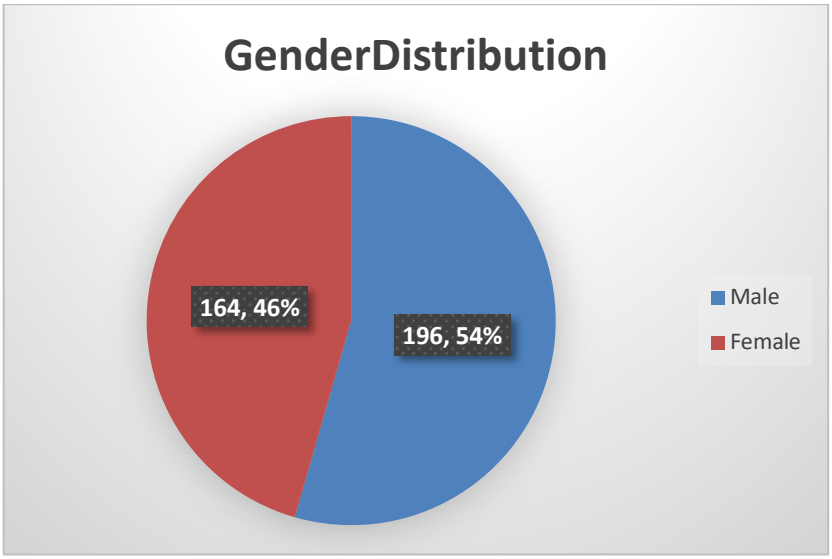

Chart 1: Gender- wise distribution of patients underwent CT urography

- Males were more (54.4% cases) as compaorange to females (45.6%)

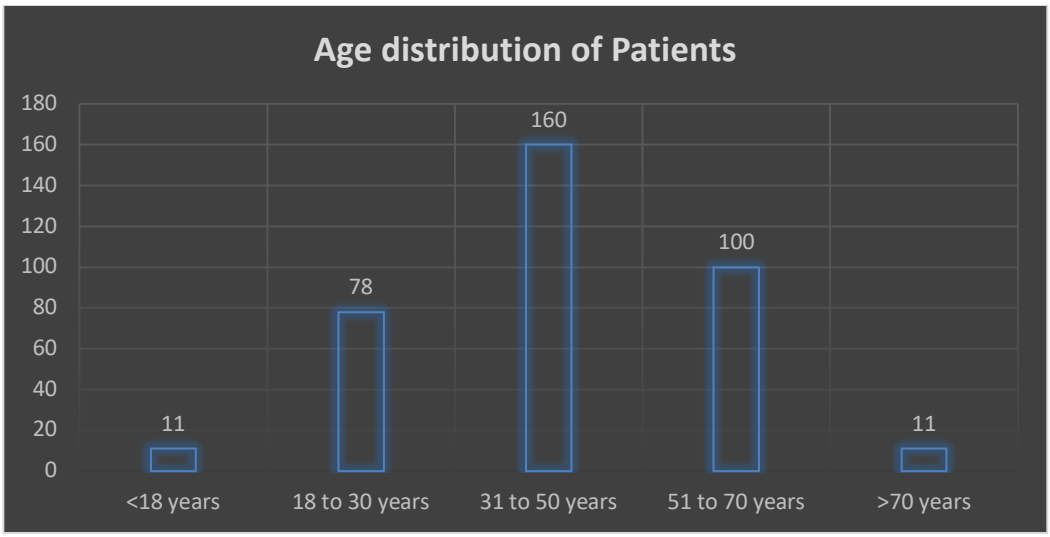

Chart 2: Age Distribution of patients

- Most of the cases were of age group 31 to 50 years (44.4%) followed by 51 to 70 years age (28%).

Table 1: Clinical presentation in patients for CT urography.

Clinical Presentation	Number	Percent
Abdominal pain with urinary complaints*	203	56.4%
Urinary complaints in known abdomino-pelvic Malignancies	65	18.1%
Screening in known abdomino pelvic malignancies without urinary complaints.	48	13.3%
Trauma	44	12.2%
Total	360	100.00%

- Abdominal pain with urinary complaints was seen in maximum number of patients (203 cases-56.4%) with urinary symptoms like dysuria/urinary urgency/polyuria/ hematuria. Urinary complaints in known abdomino-pelvic malignancies was seen in 18% cases.

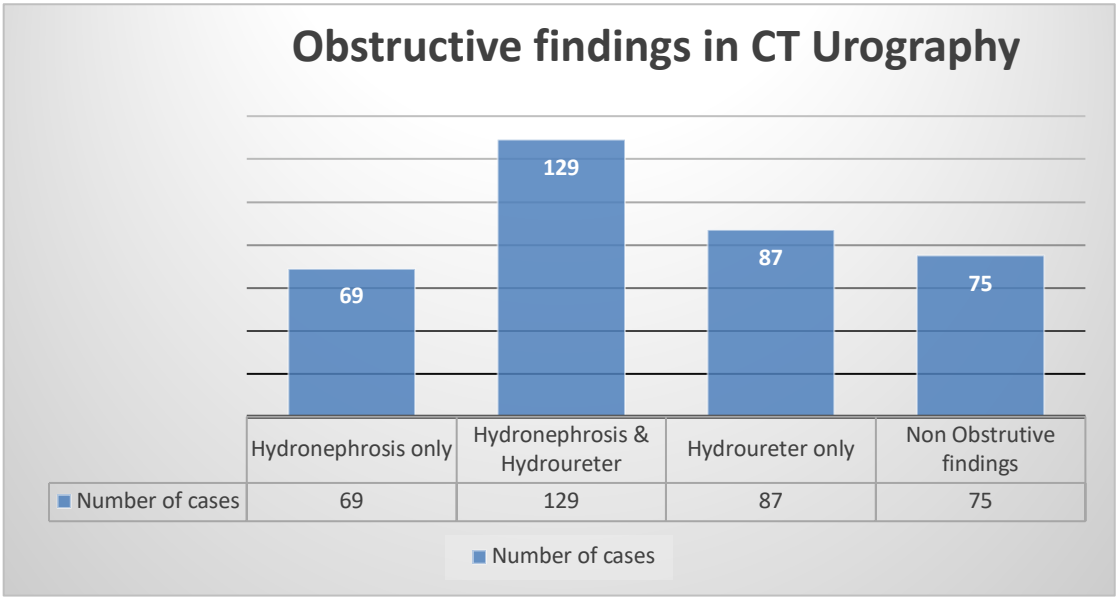

Chart 3: CT urography Findings in Cases.

- Out of 360 patients in our CT urography study, maximum number of 129 cases (35.8%) had obstructive findings like hydronephrosis & hydroureter, followed by hydroureter only in 87 cases. 69 cases had only hydronephrosis. Total of 216 cases had hydroureter.

Table 2: Imaging findings of ureteric abnormalities according to causes

Imaging findings of ureteric abnormalities	Number of cases	Percent
Ureteric dilatation secondary to congenital abnormality	22	6.1%
Ureteric dilatation secondary to obstructive calculus	87	24.2%
Ureteric dilatation secondary to benign stricture	38	10.6%
Ureteric dilatation secondary to obstruction by external malignant mass	54	15%
Ureteric dilatation secondary to other causes (clots/in situ malignancy/bladder outlet obstruction)	15	4.2%
PUJ Abnormality	69	19.2%
Filling defects (due to calculus, debris, clots) only	66	18.3%
Abnormal Ureteric course	1	0.2%
Congenital abnormality (duplex collecting) only	08	2.2%
Total	360	100%

- **Ureteral abnormalities was seen in total of 360 patients in our study**
- **Most common abnormality was dilatation of ureter which was seen in 216 cases** that had maximum number of cases secondary to obstructive calculus in 87 cases (accounting for 24.2% of total cases). Second most common cause for ureteral dilatation was due to obstruction by external malignant mass accounting for 54 cases (15% cases). Second common ureteral abnormality was at Pelvi-ureteric junction (PUJ) in 19.2 % cases.
- **75 cases had none of the obstructive findings**, but had non obstructive ureteral findings like non obstructive filling defects due to calculi, clots, etc or abnormal ureteric course or only congenital abnormality. The non obstructive ureteral findings, filling defects were most common in 66 cases which were due to non-obstructive calculi, clots, debris, etc

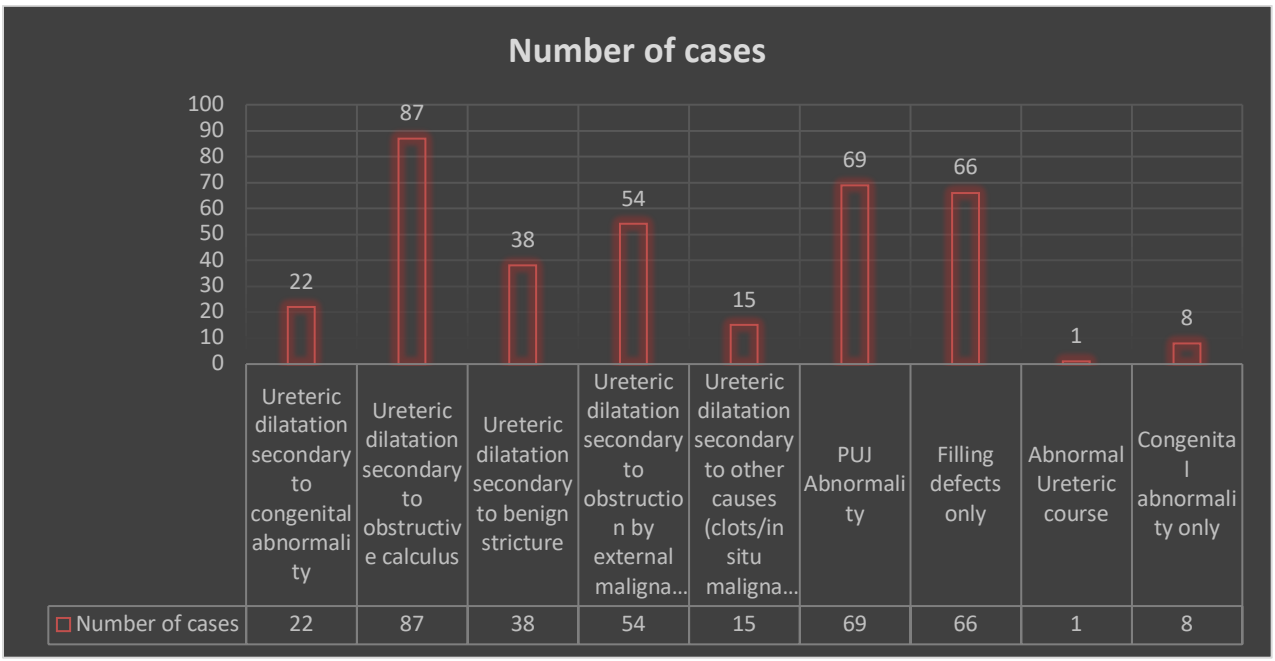

Chart 4: Imaging findings of ureteric abnormalities according to causes

CONGENITAL URETERAL IMAGING FINDING

Image 1a: On coronal MIP image of delayed excretory phase of CT urography with showing **left complete duplex collecting system.**

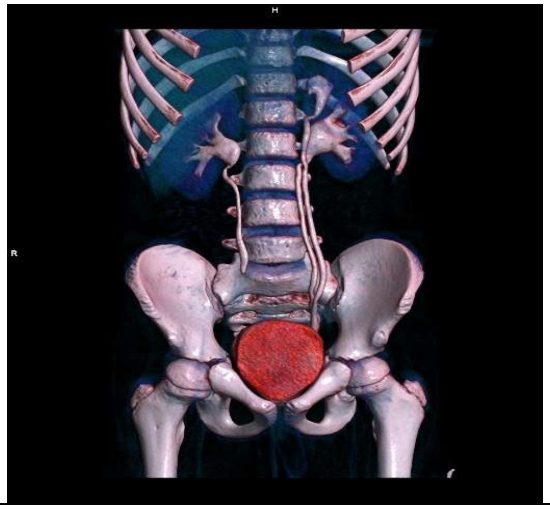

Image 1b: 3D reconstructed image of delayed excretory phase of CT urography with showing **left complete duplex collecting system.**

Image 2a: On Axial image of Nephrographic phase of CT urography showing **left ureterocele** (Orange arrow) and incidental bladder calculus.

Image 2b: On coronal MIP image of excretory phase of CT urography showing **left ureterocele** (orange arrow).

PELVI-URETRIC JUNCTION CALCULUS

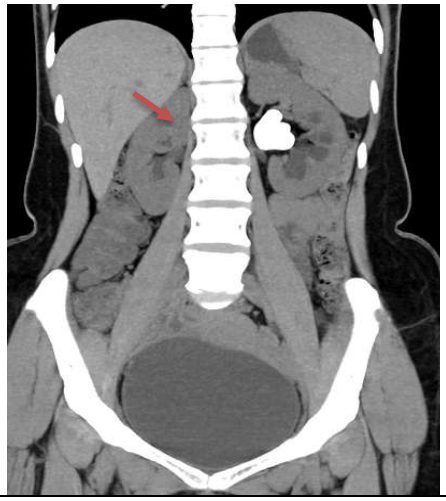

Image 3a: coronal reformated MIPimages of un enhnaced phase of CT urography showing high density **left PUJ calculus (Orange arrow)**

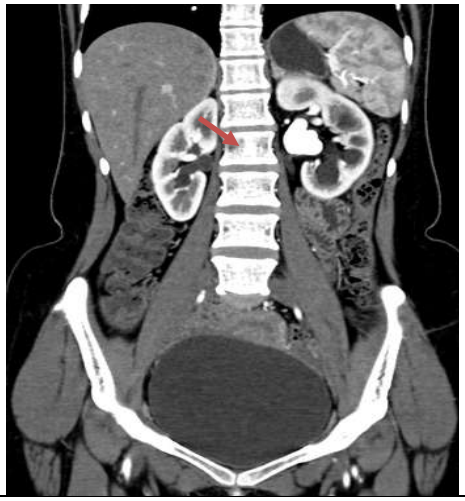

Image 3b: coronal reformated images of nephrogenic phase of CT urography showing high density **left PUJ calculus (Orange arrow)**

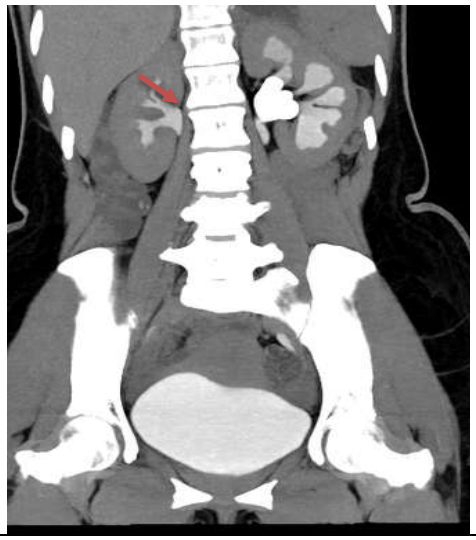

Image 3c: coronal reformated MIPimages of excretory phase of CT urography showing high density **left PUJ calculus (Orange arrow)**

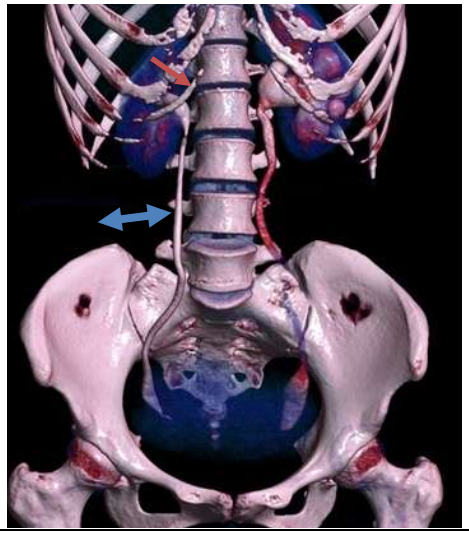

Image 3d: VRT 3D image of excretory phase of CT urography showing high **left PUJ calculus (Orange arrow) with opacified bilateral ureters(Blue arrow)**

URETERAL CALCULI

Image 4a: coronal reformated images of un enhnaced phase of CT urography showing high density **left ureteric calculus (orrange arrow)**

Image 4b: coronal reformated MIP images of nephrogenic phase of CT urography showing high density **left ureteral calculus (orange arrow)**

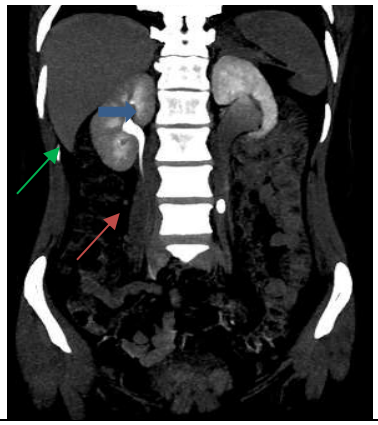

Image 4c: coronal reformated MIP images of excretory phase of CT urography showing high density **left ureteral calculus (Orange arrow) with minimally excretion of contrast in left renal pelvis (blue arrow) and normal right ureter (green arrow).**

VESICO-URETERIC JUNCTION CALCULUS

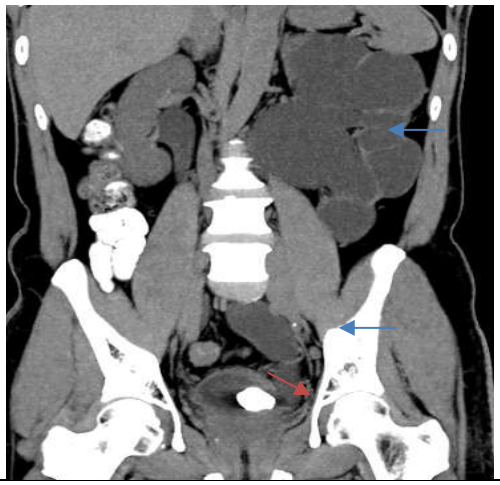

Image 5a: In the coronal reformated images of un enhnaced phase of CT urography showing **left VUJ calculus** (Orange arrow) casuing **gross hydroureteronephrosis (**Blue arrow**)**

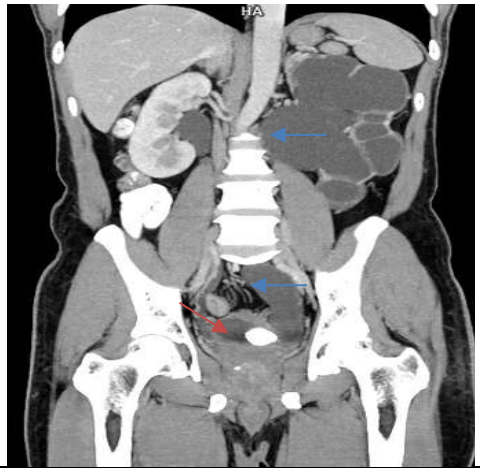

Image 5b: In the coronal reformated MIP images of nephrogenic phase of CT urography showing **left VUJ calculus** casuing **severe hydroureteronephrosis (**Blue arrow**)**

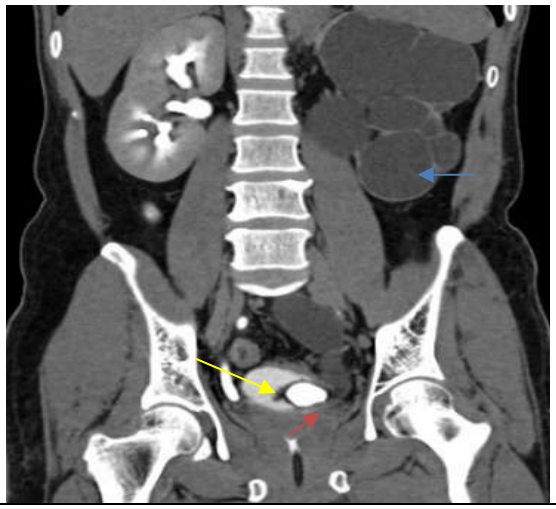

Image 5c: In the coronal reformated images of delayed phase of CT urography in same patient showing **left VUJ calculus** (Orange arrow) casuing **gross hydroureteronephrosis (**Blue arrow**). Bladder (yellow arrow) opacified with contrast excreted by right kidney.** Note there is no excretion of contrast in left kidney.

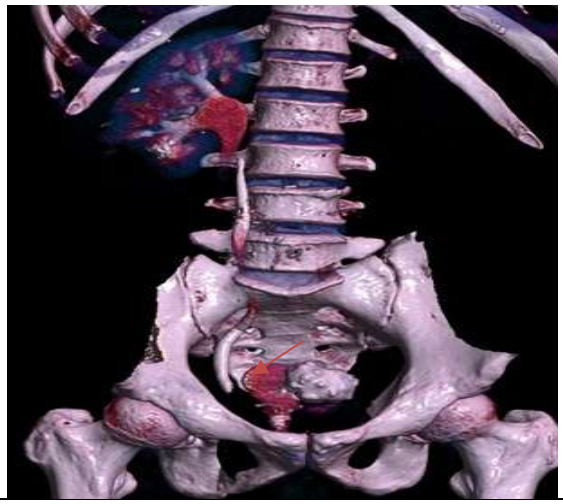

Image 5d: On VRT IMAGE **left kidney & ureter is not visualised** due to non excretion of contrast **and A large calculus (Orange arrow) in pelvis.**

MALIGNANT CAUSES

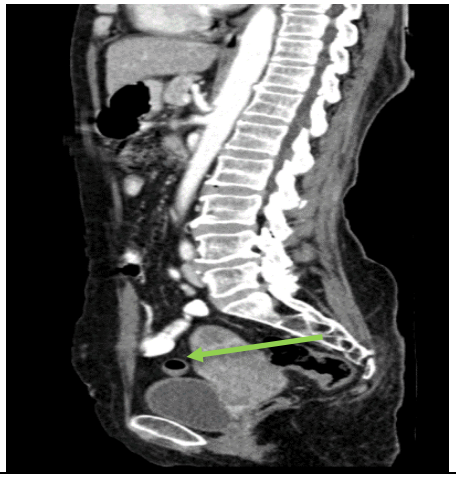

Image 6a: Sggital image of known **Ca Cervix (green arrow**) on venous phase of Contrast abdomen & pelvis scan

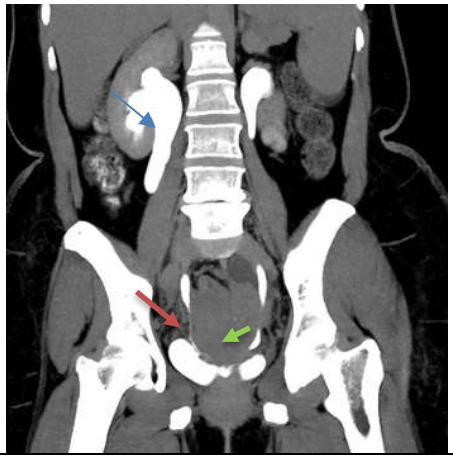

Image 6b: Coronal reformatted MIP image of known **Ca Cervix (Green arrow**) on delayed phase of Contrast abdomen & pelvis scan showing **right lower uretral involvemnt (orange arrow) with hydrouretero nephrosis (blue arrow)**

Table 3: Distribution according to causes of ureteral filling defects only Table 3: Distribution according to causes of ureteral filling defects only

Causes of ureteral filling defects	Number	Percent
Non obstructive ureteral Calculus	28	42.40%
Malignancy	19	28.7%
Clot/sloughed papillae	2	3.0%
Inflammatory or infective stricture	12	18.2%
Post-operative intervention	5	7.7
Total	66	100%

- Filling defect due to non obstructive calculus was maximum in 42.4% cases followed by malignancy 28.7% cases.

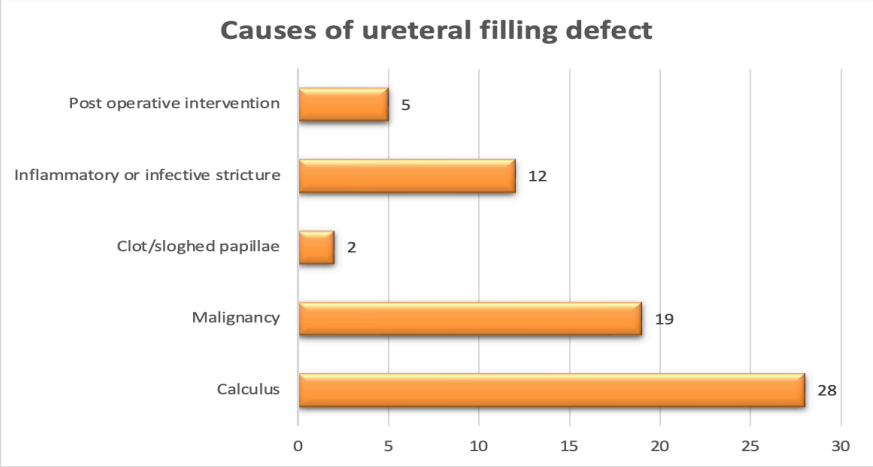

Chart 5: Distribution according to causes of ureteral filling defects

INFLAMMATORY OR INFECTIVE STRICTURE

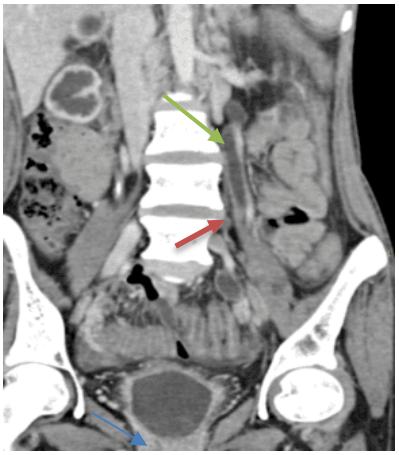

Image 7a: In this **case of urinary tarct Tuberculosis**, coronal image of nephrographic phases of CT urography shows thickened and shrunken urinary bladder giving **Thimble bladder appearance(Blue arrow)** and **left ureteral thickening with dilatation (Orange arrow) and stricture (Green arrow)**

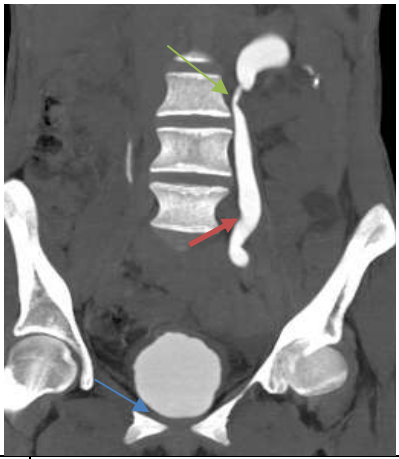

Image 7b: In this **case of-urinary tract Tuberculosis**, coronal MIP image of delayed phase of CT urography shows thickened and shrunken urinary bladder giving **Thimble bladder appearance(Blue arrow)** and **left ureteral dilatation (Orange arrow) and stricture (Green arrow)**

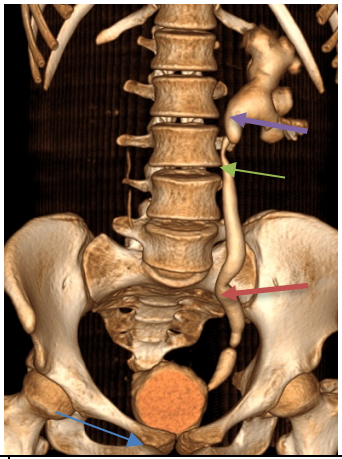

Image 7c: In the same patient of **case of urinary tract Tuberculosis**, 3D reconstructed image **shows left ureteral stricture (green arrow), ureteral dilatation (orange arrow), hydronephrosis (Violet arrow) and thimble bladder (Blue arrow).**

Discussion

The present study was done at our tertiary care centre on 360 patients to assess the various types of ureteric abnormalities in CT Urography and characterize the site, nature and severity of obstruction in cases of ureteric obstruction using CT Urography. In the present study, male patients were more (54.4%) as compared to females (45.6%). Most of the cases were of age group 31 to 50 years (44.4%) followed by 51 to 70 years age (28%). This is similar to the studies of Sharma K et al[5], Rathva AM et al[8] and Ahmed Moawad MM et al[7]. Sharma K et al[11] prospective study assessing role MDCT urography in evaluation of obstructive uropathy found 31 male and 19 female patients with a mean age of the patients was 33.5±14.3 years (range 10-61 years). Rathva AM et al[8] study assessing and characterizing the lesions involving kidneys and its relation to surrounding structure found majority of the patients were male 34 and Female were 16 and most of the patients were in the age group of 41-50 years (24%) followed by 11-20 (14%) respectively. Ahmed Moawad MM et al[7] study assessing the value of multislice CT urography in patients with obstructive uropathy found 30 patients (19 male and 11 female), who presented with urinary tract obstruction and age of the patients ranged from 2 days to 70 years, with an average age of presentation of about 40.3 years.

In our study, abdominal pain with urinary complaints like dysuria/urinary urgency/polyuria/ hematuria was seen in maximum number of patients (203 cases-56.4%). Urinary complaints in known abdomino-pelvic malignancies was seen in 18% cases. Gaudiano C et al[11] noted similar observations in their study.

Out of 360 patients in our CT urography study, maximum number of 129 cases (35.8%) had hydronephrosis & hydroureter, followed by hydroureter only in 87 cases. 69 cases had only hydronephrosis. 216 cases had hydroureter-ureteral dilatation overall. 75 cases had none of the obstructive findings, but with non obstructive ureteral findings like non obstructive filling defects due to calculi, clots, etc or abnormal ureteric course.

Sharma K et al[5] prospective study showed most common cause of urinary obstruction was urinary tract calculi in 33 subjects (66%) Second most common cause was urinary bladder masses, other less common causes of urinary obstruction were PUJ obstruction, ureteric stricture and extrinsic compression of ureter by enlarged lymph nodes. In our study, Ureteral abnormalities was seen in total of 360 patients. Most common ureteral abnormality was dilatation of ureter (Hydroureter), it was seen in 216 cases. Hydroureter secondary to obstructive calculus was seen in 87 cases (accounting for 24.2% of total cases). CT urography helps in accurately measuring the size, site, shape and density of calculus and also to assess the severity of its obstruction. Complications due to obstructive uropathy can also be well studied in detail. Non-contrast phase in CT urography is the best imaging modality for detection of urinary calculi and can accurately depict site and and size of calculus. With MDCT urography, the functional status of the kidneys can be evaluated simultaneously on excretory & delayed phases [7,8,9]Second most common cause for ureteral dilatation was due to obstruction by external malignant mass accounting for 54 cases. In patients with known or newly diagnosed malignancies of ca cervix, ca ovary, ca uterus, ca bladder, metastases, renal or ureteral malignancies, retroperitoneal masses with involvement of urinary system can be studied which helps in management of the malignancy. CT urography also provides high resolution imaging of extensions, involvements, and abdomino-pelvic metastatic lesions simultaneously in case of malignant lesions, which have prognostic implications. Multiplanar Reconstruction (MPR), Maximum Intensity Projection (MIP) and Volume Rendered Technique (VRT 3D) images

provide important additional information which might be missed in initial imaging.

Second most common ureteral abnormality was at Pelvi-ureteric junction (PUJ) in 19.2 % cases. Out of 75 patients having non obstructive ureteral findings, filling defects were most common in 66 cases which were due to non-obstructive calculi, clots, debris, etc. It was seen in concordance with sharma K et al[5] mentioned above.

The most characteristic abnormalities on IVU are an asymmetrical nephrographic density and excretion of contrast material. With advances in MDCT, the cause and the level of obstruction can be easily identified even without contrast injection[12.13].

The most important factor for deciding management of ureteric calculi is the size of the stone which can be most accurately measures using CT scan. An unenhanced phase is used to detect stones, calcifications, hemorrhages, clots, and to measure the attenuation coefficients of the renal and urothelial masses[14]. A corticomedullary phase, occurring between 30 and 40s after contrast medium administration, is used to evaluate suspected vascular abnormalities or arterial enhancement[14,15], while a nephrographic phase, acquired 90–110 s after contrast medium administration, improves detection and characterization of renal lesions[14]. The excretory phase obtained 8–12 min after contrast agent administration, assesses the abnormalities of the urothelium with the distension and the opacification of the collecting systems, ureters and bladder[15]. CT urography can also be useful in interventions of urinary system for Percutaneous Nephrostomy tube placement, pig tail insertions and also for post procedural assessment to localize the tubes & catheters/stents. Delayed phase of CT urography can also be applied in Contrast CT study of abdomen & Pelvic scans on case to case basis to study ureteric involvements & pathologies.

Conclusion

This study outlines the most common ureteric abnormalities in patients referred for contrast enhanced CT urography. Imaging findings of ureteral abnormalities were obstructive findings like hydronephrosis & or hydroureter or non obstructive findings like ureteral filling defects. Various phases of CT urography has multiple uses like unenhanced phase to detect stones, calcifications, hemorrhages, clots. Corticomedullary phase to evaluate suspected vascular abnormalities or arterial enhancement, while a nephrographic phase, improves detection and characterization of renal lesions if any detected. The excretory phase assesses the abnormalities of the urothelium with the distension and the opacification of the collecting systems, ureters and bladder. In patients with known or newly diagnosed malignancies of ca cervix, ca ovary, ca uterus, ca bladder, metastases, renal or ureteral malignancies, retroperitoneal masses with involvement of urinary system can be studied which helps in management of the malignancy. CT urography is also useful in interventions like Percutaneous Nephrostomy tube placement, pig tail insertions and also for post procedural assessment to localize the tubes & catheters/stents.

Delayed phase of CT urography can also be applied in Contrast CT study of abdomen & Pelvic scans on case to case basis to study ureteric involvements & pathologies. It is an useful “one shop stop” for imaging in urinary tract pathologies.

References:

1. Vedaraju Kadaba Shamachar et al., Evaluation of imaging abnormalities of ureter using MDCT urography. www.ijars.net. 2017 Apr,Vol-6(2):RO01-RO07.

2. Grossfeld GD, Litwin MS, Wolf JS Jr et al. Evaluation of asymptomatic microscopic hematuria in adults: the American Urological Association best practice policy. II. Patient evaluation, cytology, voided markers, imaging, cystoscopy, nephrology evaluation, and follow-up. Urology. 2001;57:604-610.
3. Joffe SA, Servaes S, Okon S et al. Multi-detector row CT urography in the evaluation of hematuria. RadioGraphics, 2003;23(6):1441–1455.
4. Potenta, Agostino, Sternberg et al., CT Urography for the evaluation of ureter. radiographics.rsna.org. May-Jun 2015,Vol 35(3).
5. Sharma K, Yadav N, Mittal P et al. Role of MDCT Urography in Evaluation of Patients with Obstructive Uropathy: A Prospective Study of 50 Patients in a Rural Tertiary Care Hospital. International Journal of Anatomy, Radiology and Surgery. 2018;7(3):RO17-RO21.
6. Soriano RM, Penfold D, Leslie SW. StatPearls [Internet]. StatPearls Publishing; Treasure Island (FL): Anatomy, Abdomen and Pelvis, Kidneys, 2021.
7. Ahmed Moawad MM, El-Zawawy MS. The role of multidetector computed tomography urography in the evaluation of obstructive uropathy. Menoufia Med J 2015;28:554-558
8. Rathva AM, Singla H. MDCT urography as a one stop shop for urinary tract abnormalities at present era. IAIM Abstract 6; 2016;3(3):5264.
9. Zhao DL, Jia GS, Chen P et al. Diagnostic value of 64-slice spiral computed tomography imaging of the urinary tract during the excretory phase for urinary tract obstruction. Exp Ther Med. 2017;14: 4761-4766.
10. . Kataria B, Nilsson Althén J et al. Image quality and pathology assessment in CT Urography: when is the low-dose series sufficient?. BMC Med Imaging 19, 64 (2019).
11. Gaudiano C, Tadolini M, Busato F et al. Multidetector CT urography in urogenital tuberculosis: Use of reformatted images for the assessment of the radiological findings. A pictorial essay. Abdom. Radiol. 2017;42:2314–2324
12. Dyer RB, Chen MY, Zagoria RJ. Intravenous urography: technique and interpretation. Radiographics 2001; 21:799-824.
13. Cronin CG, Lohan DG, Blake MA et al. Retroperitoneal fibrosis: review of clinical features and imaging findings. Am J Roentgenol 2008; 191 :423-431.
14. Caoili EM, Cohan RH. CT urography in evaluation of urothelial tumors of the kidney. Abdom. Radiol. 2016;41:1100–1107.
15. Cheng K, Cassidy F, Aganovic L et al. CT urography: How to optimize the technique. Abdom. Radiol. 2019;44:3786–3799.