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Original Research Article

Characterisation of ureteric obstructive lesions using single bolus CT urography: a single centre study

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ABSTRACT

Background: CT urography which has replaced IVP is an imaging procedure in which the contrast is injected and phases of CT scan are taken to study the entire urinary system. Advantages include the use of multiplanar reconstruction (MPR), reformatted images, maximum intensity projection (MIP) and three-dimensional (3D) reconstruction which gives valuable information. This study aimed to characterize ureteric abnormalities, site, nature and severity of obstruction in cases of begin and malignant obstructive uropathy using CT Urography.
Methods: This is a tertiary hospital Government medical college, Aurangabad based ddescriptive Cross sectional observational study on 360 patients referred for CT urography with clinical signs and symptoms of urinary tract, having ureteric imaging abnormalities from November 2020 to December 2022. Siemens somatum 128 slice CT High Definition scanner was used.
Results: Benign obstructive causes were more common in our study accounting for 80.7% cases. Among total of 74 malignant cases, 55 cases had obstructive involvement of urinary system with maximum of Ca cervix and ovary predominantly at VUJ. Benign causes were more common in mild hydronephrosis predominantly and malignant involvement of ureters were most commonly seen in severe hydronephrosis.
Conclusions: This study highlights the severity and site of obstructive uropathy in benign and malignant causes. It implies application of delayed phase of CT urography (hybrid CT urography) on case to case basis to study ureteric involvements based on various pathologies.

Keywords: Ca cervix, Ca ovary and hybrid CT urography, Computed tomography urography, Hydroureter, Hydronephrosis, Obstructive uropathy, Pelvic malignancies, Ureteral calculi, VUJ

INTRODUCTION

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.[1-3] 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.[3] 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. It has non-enhanced phase, enhanced nephrogenic phase, excretory phase and sometimes delayed excretory phase depending on obstruction. The techniques used in CT Urography are Single contrast media bolus CT Urography technique, Triple phase (Conventional single energy CT), Dual phase -split bolus technique (Conventional single energy CT) and single phase Dual energy CT. Most commonly used is single contrast media bolus CT Urography technique.[4-6] 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.[2,3,7] 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. The major disadvantage of CT urography compared with excretory urography is the radiation exposure, with the doses of four-phase CT urography of about 25-35 mSv compared with a mean effective dose of 3.6 mSv for excretory urography.[6] 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. Intraluminal causes of urinary tract obstruction include scarring, stones, papillae sloughing and blood clots. Extra luminal extrinsic causes include factors which compress over ureter and causes obstruction like cancer of cervix, ovary, colon, renal, urinary bladder etc, metastases, sarcoma, trauma and enlarged lymph nodes. It can cause either unilateral or bilateral obstruction depending on location[7-9]

This study aimed to characterize ureteric abnormalities, site, nature and severity of obstruction in cases of begin and malignant obstructive and non obstructive uropathy using CT urography.

METHODS

Study design

A hospital based observational descriptive cross sectional study was conducted at Government medical college hospital, Aurangabad a tertiary care centre on 360 patients to assess ureteric abnormalities, in CT Urography from November 2020 to December 2022 in. 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, 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 and not willing for giving consent were excluded.

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. No 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.

RESULTS

This study was done on 360 patients with males being more (54.4% cases) as compared to females (45.6%). CT urography obstructive findings like hydronephrosis and hydroureter, are tabulated in Table 1. Non obstructive ureteral findings included non obstructive filling defects due to calculi, clots, etc or abnormal ureteric course or only congenital abnormality.

Table 1: CT urography findings in all cases.

CT urography findings	Number of cases	Percent
Hydronephrosis only	69	19.2
Hydronephrosis and hydroureter	129	35.8
Hydroureter only	87	24.2
Non obstructive findings	75	20.8
Total	360	100

Most common abnormality was hydroureter which was seen in 216 cases that had maximum number of cases secondary to obstructive calculus in 87 cases (24.2% of total cases). Other causes with percentage of cases are described in Figure 1.

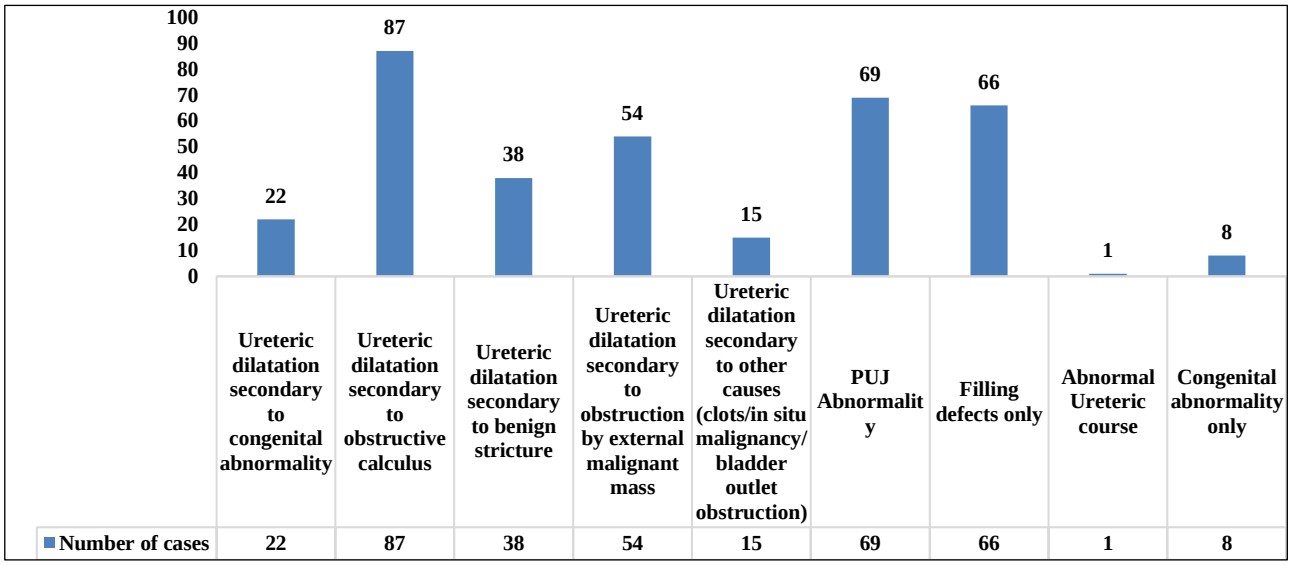

Figure 1: Imaging findings of ureteric abnormalities according to causes.

Benign causes for ureteric obstruction were more common in our study accounting for 80.7% cases. Among total of 285 patients with obstructive uropathy, 230 patients had benign causes and 55 patients had malignant causes. Out of 117 patients having obstructive calculi on CT urography, unilateral stones were seen in 75.2% cases, density was more than 450 HU in 90% cases. Calculi of size 1 cm or more were predominant among obstructive calculi.

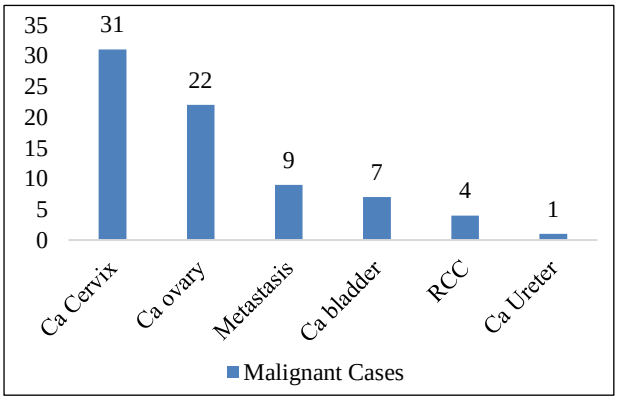

Figure 2: Various malignant masses affecting urinary system.

Among total of 74 malignant cases, 55 cases had obstructive involvement of urinary system and 19 had non obstructive involvement. 74 patients had malignant involvement in our study with Ca cervix maximum in 30 cases, followed by Ca ovaries in 22 cases and most common site of obstruction being VUJ.

Grading system of hydronephrosis by society of fetal urology

Grade 1 (mild) - dilatation of the renal pelvis without dilatation of the calyces, grade 2 (mild) - dilatation of the renal pelvis (mild) and calyces (pelvicalyceal pattern is retained), no parenchymal atrophy, grade 3 (moderate) - moderate dilatation of the renal pelvis and calyces, blunting of fornices and flattening of papillae and mild cortical thinning may be seen, grade 4 (severe) - gross dilatation of the renal pelvis and calyces, which appear ballooned, loss of borders between the renal pelvis and calyces and renal atrophy seen as cortical thinning.

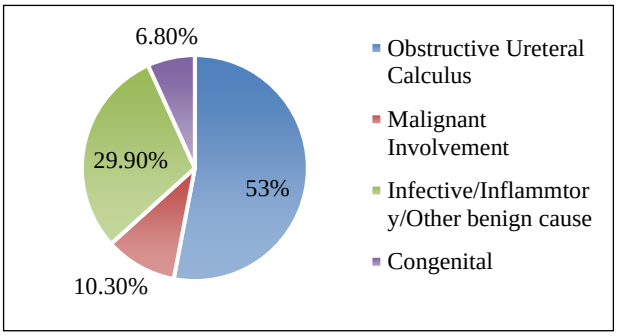

Figure 3: Distribution of patients with hydroureter with or without mild hydronephrosis according to causes.

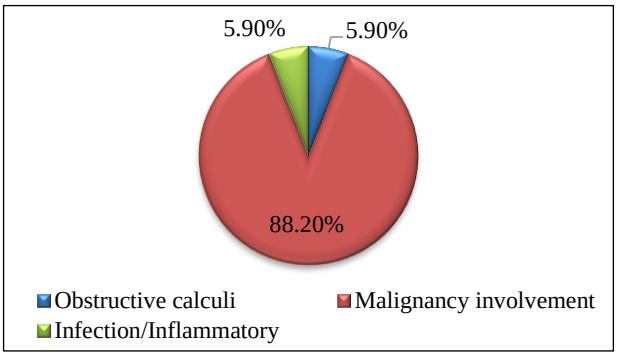

Figure 4: Distribution of patients with hydroureter and gross hydronephrosis according to causes.

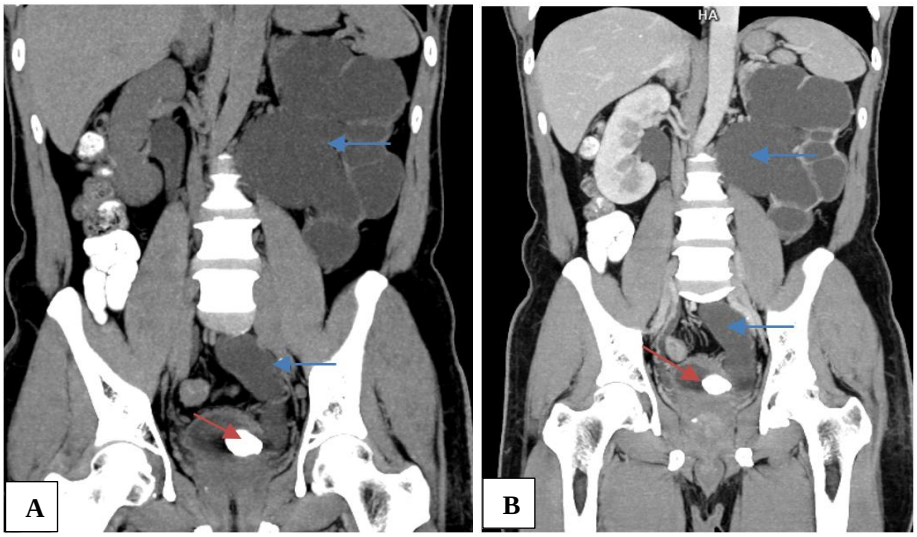

Figure 5: (A) In the coronal reformated images of un enhnaced phase of CT urography showing left VUJ calculus (red arrow) casuing gross hydroureteronephrosis (blue arrow); (B) in the coronal reformated MIP images of nephrogenic phase of CT urography showing left VUJ calculus casuing severe hydroureteronephrosis (blue arrow).

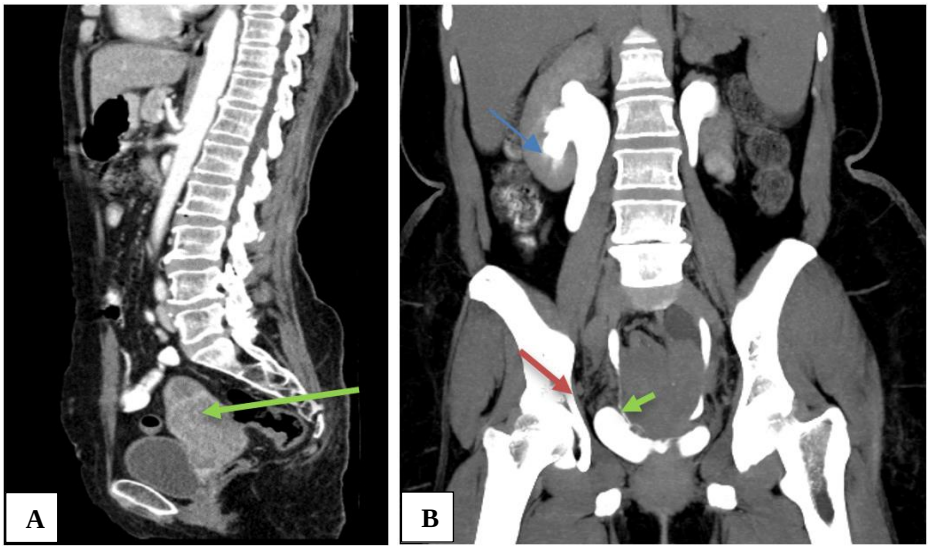

Figure 6: (A) Sagittal image of known Ca Cervix (green arrow) on venous phase of contrast abdomen and pelvis scan; (B) coronal reformatted MIP image of known Ca Cervix (green arrow) on delayed phase of contrast abdomen and pelvis scan showing right lower uretral involvement (red arrow) with hydrouretero nephrosis (blue arrow).

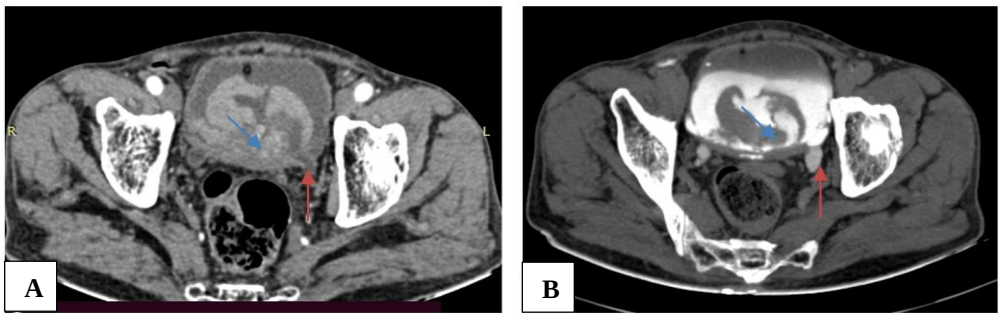

Figure 7: A) On axial nephrogenic phase of CT urography in bladder malignancy (blue arrow) involving left vesicoureteric junction (red arrow); (B) on axial excretory phase of CT urography in bladder malignancy involving left vesicoureteric junction showing left lower ureteral dilation (red arrow).

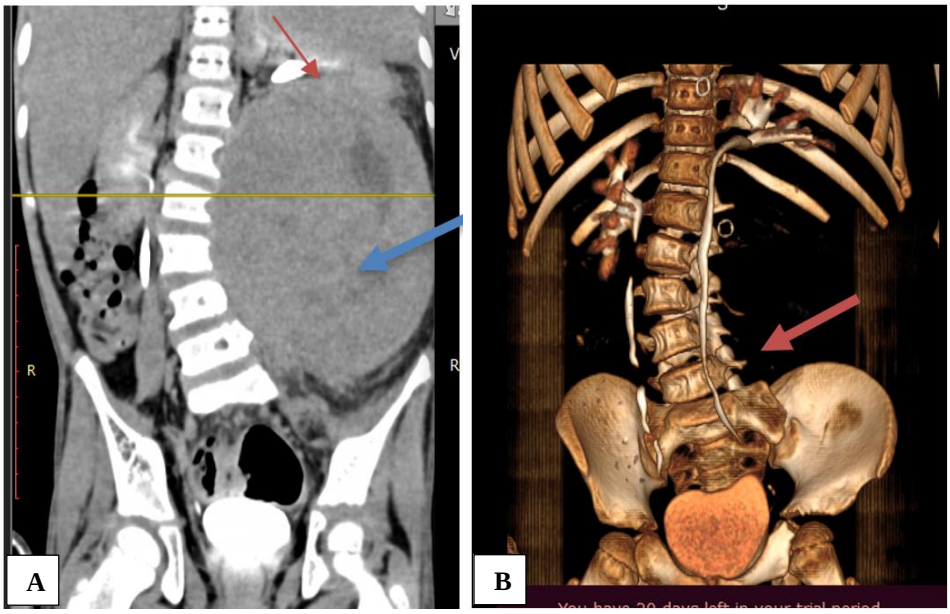

Figure 8: (A) In this case of retroperitoneal mass, on coronal reformatted MIP images of delayed phase of CT urography, the mass (blue arrow) is seen displacing left ureter (red arrow) and left kidney; B) In this case of retroperitoneal mass, on coronal reformatted MIP images of delayed phase of CT urography, the mass (blue arrow) is seen displacing left ureter (red arrow) and left kidney.

30 cases had mild hydroureter, 65 had moderate and 34 cases had severe hydroureter. Benign cause of obstructive ureteral calculi was more common in causes of mild hydroureter with 53% and in 35.4 % cases with moderate hydronephrosis whereas malignant involvement was seen in only 10.3% and 20% cases respectively. Malignant involvement of ureters was most common in patients having hydroureter with severe hydronephrosis in 88.2 % of cases (Figure 6 & 8).

DISCUSSION

In this study, abdominal pain with urinary complaints like dysuria/urinary urgency/polyuria/hematuria was seen in maximum number of patients (203 cases-56.4%). Amongst the patients having obstructive findings on CT urography, benign causes for ureteric obstruction were more common in our study accounting for 80.7% cases, rest were due to malignant causes.[10-12] Urinary complaints in known abdomino-pelvic malignancies was seen in 18% cases.[11-16] Among benign causes, obstructive calculi were most predominant.[10] Out of 230 cases having benign ureteric obstruction, most common cause found was obstructive calculi in 117 cases followed by congenital abnormality in 47 cases. Other benign causes include bladder outlet obstruction, vesico-ureteral reflux, etc. Most common congenital abnormality found in our study was PUJ obstruction in 25 cases, followed by partial ureteral duplication in 10 cases. In this study, out of 117 patients having obstructive ureteral calculi on CT urography, unilateral stones were seen in 75.2% cases, density was more than 450 HU in 90% cases. Calculi of size 1 cm or more were predominant among obstructive calculi. The most common finding is ureteral calculi as common cause of abdominal pain with dysuria and in many such cases, patients present with acute obstructive features and in these cases, rapid and accurate diagnosis is important for short term as well as long term outcome.[10] Non-contrast CT is the best imaging modality for detection of urinary calculi and can accurately depict site and size of calculus and associate back pressure changes. With MDCT urography, the functional status of the kidneys can be evaluated simultaneously.[12 -17]

Zhao et al study showed 12 patients had congenital malformations; double pelvis and ureters in 5 cases, horseshoe kidneys in 2 cases, ureteral valve disease in 2 cases, congenital mega ureter in 2 cases and ureteropelvic junction tortuosity and stricture in 1 case.[18] Zhao et al study showed 3 patients exhibited a ureteral stricture caused by urinary tract infections (urinary tuberculosis in 2 cases and inflammatory stricture in 1 case).[18] Zhao et al study showed 13 patients had malignant tumors of the urinary tract, including pelvis or ureter cancer in 9 cases and bladder cancer with ureteral involvement in 4 cases.[18]

In this study, 74 patients had malignant involvement of ureters. 55 patients had obstructive features, 19 patients had non obstructive features. Among all, patients with Ca cervix was maximum in 30 cases, followed by Ca ovaries in 22 cases.

An unenhanced phase is used to detect stones, calcifications, hemorrhages, clots, and to measure the attenuation coefficients of the renal and urothelial masses. A corticomedullary phase, occurring between 30 and 40s after contrast medium administration, is used to evaluate suspected vascular abnormalities or arterial enhancement,

while a nephrographic phase, acquired 90-110 s after contrast medium administration, improves detection and characterization of renal lesions.[19,20] 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.[19,20]

In this study, in total of 74 malignant cases, 55 patients had features of obstructive uropathy with most common site of involvement of ureter in malignant cases were VUJ in 30 cases (55.5%).

Raman et al observed MDCT urography also has proven efficacy in the evaluation of both upper and lower urinary tract transitional carcinomas and provides good adjuvant to cystoscopy and also allows simultaneous assessment of multiple lesions and associated enlarged lymph nodes.[19]

Kim et al study reported that CT urography was used successfully to detect 97% of bladder cancers and MDCTU is an accurate, noninvasive test for detecting bladder cancer with CT urography used to evaluate the upper tracts.[20]

Our study used grading of hydronephrosis classification of society of fetal urology (SFU) to grade severity of ureteric obstruction. It showed that among 129 patients having both hydronephrosis and hydroureter, hydroureter with moderate hydronephrosis was seen in maximum number of 65 cases, hydroureter with Severe hydronephrosis was seen in 34 cases and hydroureter with mild hydronephrosis was seen in 30 cases. Only Hydroureter without hydronephrosis was seen in 87 patients. Benign causes were more common in causes of hydroureter with or without mild hydronephrosis with 53% cases being obstructive ureteral calculus. Malignant involvement was seen in only 10.3% cases. Malignant involvement of ureters was most common in patients having hydroureter and severe hydronephrosis which was seen in 88.2% of cases having hydroureter and severe hydronephrosis. Obstructive calculi and infective/inflammatory/other benign causes were seen in 5.9 % cases each. These are in concordant with Zhao et al, Moawad et al, and Lin et al.[18,21,22] Our study also tailored the scan protocol by adding non contrast or delayed phase in cases of obstructive etiologies on case to case basis and proved to be a useful "one shop stop" for imaging in urinary tract imaging.[23]

Limitations

This study was observational only based on clinical and imaging features. Surgical correlation of these radiological findings were not done. CT urography cannot be done in patients with deranged KFT which is the most limiting factor.

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 and or hydroureter, non obstructive findings or only congenital abnormalities (duplex collecting system, uretreoceles). Amongst cases having mild or moderate degrees of obstruction, benign characteristic causes were more common in our study and severe obstructive causes were due to malignant etiologies.

CT urography provides high resolution imaging of extensions and abdomino-pelvic metastatic lesions simultaneously in case of malignant lesions, which have prognostic implications. 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 and pathologies. It is a useful “one shop stop” for imaging in urinary tract pathologies.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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