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Original Article

Radiology Section

Role of MDCT Urography in Evaluation of Patients with Obstructive Uropathy: A Prospective Study of 50 Patients in a Rural Tertiary Care Hospital

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ABSTRACT

Introduction: Obstructive uropathy is a relatively common clinical problem which if not treated timely can lead to irreversible renal damage. Therefore, accurate diagnosis is important for timely management.

Aim: The purpose of present study is to assess role Multidetector Computed Tomography (MDCT) urography in evaluation of obstructive uropathy.

Materials and Methods: This prospective study was conducted on 50 consecutive subjects presenting with evidence of unilateral or bilateral hydronephrosis and who were referred for CT urography for detection of site and cause obstruction. Subjects with deranged renal function tests, pregnant subjects and those with history of allergy to iodinated contrast media were excluded from the study. Patients with any past history of urinary tract surgery were not considered. CT-scan was performed with Ingenuity CT scanner (128 slice MDCT, Philips Medical Systems). Timed triphasic scans were obtained in all subjects; First phase (non contrast phase), second phase (nephrographic/venous phase) obtained following a delay of 90-100 seconds and a delayed phase (after 8-10 mins) The images were sent to on the workstation with real time Multiplanar Reconstruction (MPR) and Maximum Intensity Projection (MIP) capabilities. Side, site and cause of urinary obstruction were noted based on CT urography findings.

Results: Out of 50 subjects, urinary obstruction was unilateral in 45 subjects (90%) in our study. Only 5 subjects (10%) had bilateral urinary obstruction. Most common cause of urinary obstruction was urinary tract calculi seen in 33 subjects (66%). Second most common cause was urinary bladder masses which were causes of unilateral obstruction in 6 subjects (12%) and bilateral obstruction in 2 subjects (4%). Other less common causes were Pelvi-Ureteric Junction (PUJ) obstruction, ureteric stricture and extrinsic compression of ureter by enlarged lymph nodes. Additional other significant findings included enlarged lymph nodes (4 subjects), urinoma formation (2 subjects), recro-vesical fistula (1 subject) and ureterocele (1 subject).

Conclusion: MDCT urography is very useful for complete evaluation of obstructive uropathy and allows rapid detection of level and cause of obstruction which is critical for timely and effective management.

Keywords: Kidneys, Pelvi-ureteric junction obstruction, Renal calculi, Urinary bladder

INTRODUCTION

Obstructive uropathy is defined as obstruction to normal flow of urine which can be either due to functional or structural abnormalities of the urinary tract [1]. Obstruction of urinary tract can occur anywhere from renal tubules to the urethral meatus like in renal pelvis, ureter, bladder and urethra. Urinary obstruction can be extra luminal or intra luminal and can be due to variety of congenital and acquired causes. Obstruction of urinary tract can occur during any phase of life, like childhood, adulthood or even during foetal development. Site of obstruction can be proximal like calyces or as distal as urethral meatus. Intraluminal causes of urinary tract obstruction include scarring, stones, papillae sloughing and blood clots. Extra luminal causes include factors which place pressure over ureter and causes obstruction like cancer stricture, enlarged uterus, trauma and enlarged lymph nodes. It can cause either unilateral or bilateral obstruction depending on location [2].

Many imaging modalities are available to evaluate the patients of obstructive uropathy which include plain radiographs, Intravenous Urography (IVU), Ultrasonography (USG), CT (including CT urography), MRI (including MR urography) and

radionuclide studies. USG scores over IVU in detecting the collecting system dilatation in cases of obstruction even when the renal functions are impaired but lacks specificity. However, despite the ease of demonstration of the dilated upper tract USG has limitations of its inability to reveal mid third of ureters even if they are dilated. Furthermore, USG does not provide the functional status of renal tract [3].

MR urography is a highly useful imaging technique in obstructed urinary system but it provides less diagnostic image quality relatively when compared to CT urography. Also MR urography is time consuming and expensive [4]. Technology advances in CT resulted in better imaging of urinary tract that surpasses older imaging techniques. New MDCT scanners allow rapid acquisition with increase in volume coverage, better temporal and spatial resolution and isotropic reconstructions in any plane and also virtual cystoscopy images can be obtained [5].

For many urological conditions like, urolithiasis, urinary tract infection, obstructive uropathy, renal masses and trauma, CT is now the investigation of choice. Urinary tract anatomy can be visualised accurately using CT urography [4]. It also allows excellent visualisation of any extrinsic causes of urinary obstruction.

MATERIALS AND METHODS

This prospective study was conducted in Radiodiagnosis Department of Maharishi Markandeshwar Institute of Medial Sciences and Research, Ambala, India, from November 2017 to March 2018 on 50 consecutive subjects presenting with evidence of unilateral or bilateral hydronephrosis and who were referred for CT urography for detection of site and cause obstruction. Study was approved by the ethical committee. Informed consent was obtained from all the subjects/guardians. Subjects with deranged renal function tests, pregnant subjects and those with history of allergy to iodinated contrast media were excluded from the study. Patients with any past history of urinary tract surgery were also excluded from the study.

CT-scan was performed with Ingenuity CT scanner (128 slice MDCT, Philips Medical Systems). Neural or positive contrast was used depending upon clinical situation. CT parameters for acquisition were with pitch of 1 and collimation of 64 x 0.625. Images were reconstructed at a slice thickness of 0.625 mm. First phase was initial non contrast phase. Second phase was nephrographic/venous phase obtained following a delay of 90-100 seconds after injecting 80-120 mL of intravenous non-ionic iodinated contrast to study the renal parenchyma. Second phase was followed by a delayed phase (after 8-10 mins) from injecting of the contrast to evaluate the excretory function of the kidneys and for the visualisation of the ureters. Additional more delayed scans were done wherever required.

The images were viewed on the workstation with real time MPR and MIP capabilities. After identification of kidneys and urinary tract structures, urinary obstruction was assessed to either unilateral or bilateral. Then site and cause of obstruction was identified using realtime multiplanar images. Any associated findings likely lymph nodes, metastasis, ureteroceles and any other significant findings were also noted.

STATISTICAL ANALYSIS

Statistical analysis was done using Stat Pac version 4.0 (StatPac, Inc., Bloomington, MN).

RESULTS

Out of the total 50 subjects in the study, 31 were male and 19 were female. Mean age of the patients was 33.5±14.3 years (range 10-61 years). Urinary obstruction was unilateral in most of the subjects (90%) in our study. Only 10% of subjects had bilateral urinary obstruction. Most common cause of urinary obstruction was urinary tract calculi which accounted for a total of 33 subjects (66%) (62% had unilateral obstruction and 4% had bilateral urinary obstruction). Out of these, 9 subjects had calculi in the renal pelvis and 24 subjects had ureteric calculi. Second most common cause was urinary bladder masses which were causes of unilateral obstruction in 6 subjects (12%) and bilateral obstruction in 2 subjects (4%). Other less common causes of urinary obstruction were PUJ obstruction, ureteric stricture and extrinsic compression of ureter by enlarged lymph nodes [Table/Fig-1,2]. MDCT urography also detected other significant findings which included enlarged lymph nodes (4 subjects), urinoma formation (2 subjects), recro-vesical fistula (1 subject) and ureterocele (1 subject) [Table/Fig-3].

Cause		Number (%)
Unilateral urinary obstruction (45)	Urinary calculi	31 (62%)
	Urinary bladder mass (es)	6 (12%)
	PUJ obstruction	3 (6%)
	Ureteric stricture	3 (6%)
	Extrinsic ureteric compression	2 (4%)
Bilateral urinary obstruction (5)	Urinary calculi	2 (4%)
	Urinary bladder mass(es)	2 (4%)
	Partial PUJ obstruction	1 (2%)

[Table/Fig-1]: Showing various causes of urinary obstruction detected on MDCT urography.

Urinary calculi	Number (%)
Total	33 (66%)
Renal pelvic	9 (18%)
Ureter	24 (48%)

[Table/Fig-2]: Showing site and distribution of urinary calculi detected on MDCT urography.

Associated Findings	Number
Enlarged lymph nodes	4
Urinoma formation	2
Recto-vesical fistula	1
Ureterocele	1

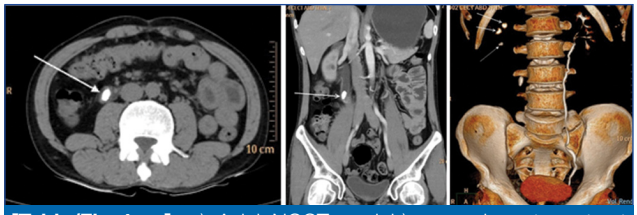
[Table/Fig-3]: Showing associated significant findings detected on MDCT urography.

DISCUSSION

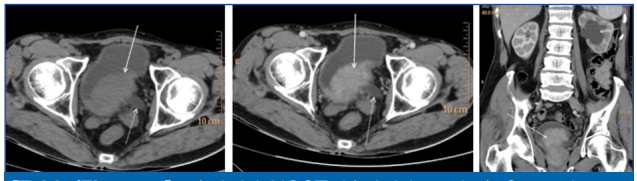
MDCT urography is an excellent imaging modality in obstructive uropathy and allows rapid imaging and allows simultaneous assessment of intraluminal and extra-luminal obstructive causes, site of obstruction as well as enhancement and excretion status of the kidneys.

In present study, urinary obstruction was mostly unilateral 45 subjects (90%) with only 5 subjects (10%) presenting with bilateral obstruction. Although, unilateral obstruction is much more common than bilateral obstruction, this difference is exaggerated in our study because many of the subjects with bilateral urinary obstruction have deranged renal function tests and therefore were excluded in our study. The most common cause of obstructive uropathy in our study was urinary calculi (accounting for 66% of total subjects) [Table/Fig-4a-c]. The calculi can be in the renal pelvis or more commonly in the ureter involving vesio-ureteric junction. This is consistent with many previous studies [6-8]. Non-contrast CT (NCCT) is the best imaging modality for detection of urinary calculi and can accurately depict site and size of calculus and associate back pressure changes [9]. With MDCT urography, the functional status of the kidneys can be evaluated simultaneously [7].

Second most common cause of urinary obstruction was due to urinary bladder masses which can cause urinary obstruction due to involvement of vesico-ureteric junction (VUJ) [Table/Fig-5a-c] which can be unilateral or bilateral. In our study, six subjects had unilateral VUJ involvement and two subjects had bilateral VUJ involvement. It is similar the study by Moawad MM et al., [7]. Urinary bladder masses are most commonly transitional cell carcinomas which can be multifocal. MDCT urography allows rapid detection of site and number of lesions. It can also detect transmural tumour extension and allows simultaneous detection of abdominal and pelvic lymphadenopathy and any associated hepatic or bony metastasis [10].



[Table/Fig-4a-c]: a) Axial NCCT; and b) coronal post contrast nephrographic images showing hyperdense calculus in right upper ureter (white arrows); c) Excretory phase volume rendered image showing excretion of into dilated calyces (white arrows). Also noted is right renal calculus in middle calyx (dotted white arrow).

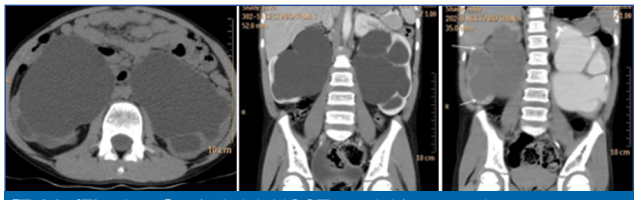


[Table/Fig-5a-c]: a) Axial NCCT; b) Axial; and c) Coronal post contrast nephrographic phase images showing soft tissue polpyoidal mass along bladder base on left side involving left VUJ (white arrow) and dilated left distal ureter (dotted white arrow in 5a and 5b) and hydronephrotic left kidney (dotted white arrow in 5c).

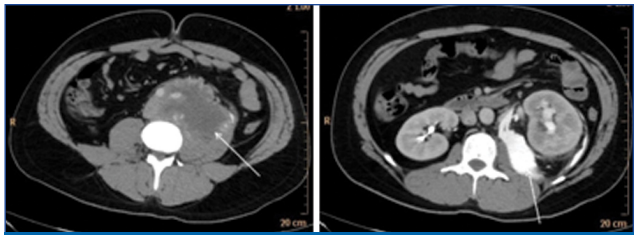
Other less common causes of obstructive uropathy were PUJ obstruction [Table/Fig-6a-c], ureteric stricture and extrinsic compression of ureter by enlarged lymph nodes.

In addition to evaluation of obstructive uropathy, MDCT can detect many significant associated findings which can have significant bearing on patient management. In our study, in patients with urinary bladder masses, MDCT additional detected enlarged lymph nodes in 4 subjects. In addition, one patient with urinary bladder mass had additionally recto-vesical fistula. Two subjects had urinary leak secondary to obstructive uropathy and associated urinoma formation [Table/Fig-7a,b] and one patient additionally had ureterocele formation.

Comparison of our study with previous similar studies in literature [Table/Fig-8]. The most common cause of urinary obstruction in various studies across literature is urinary calculi and in many such cases, patients present with acute obstructive features and in these cases, rapid and accurate diagnosis is important



[Table/Fig-6a-c]: a) Axial NCCT; and b) coronal post contrast nephrographic phase images showing bilateral PUJ obstruction with dilated and ballooned out bilateral renal pelvis; c) Coronal excretory phase image showing good excretion of contrast into pelvi-calyceal system on left side and only mild excretion into pelvi-calyceal system on right side (white arrow).



[Table/Fig-7a,b]: a) Axial post contrast excretory phase images showing large lymph nodal mass (white arrow) causing compression of left ureter with hydronphrotic left kidney; and b) Urinoma in left perinephric space (white arrow).

Study	Urinary Obstruction (Unilateral/Bilateral)	Urinary Calculi	Urinary Bladder Masses/VUJ Infiltration	PUJ Obstruction	Ureteric Stricture	Extrinsic Compression	Other Causes
Ayekpam M et al., [1]	-	71.1%	4.4%	-	13.3%	6.6%	4.6%
Jivnani DA and Shah DS [6]	-	65.6%	7.8%	9.3%	7.8%	1.6%	7.9%
Moawad MM and El-Zawawy MS [7]	96.6%/3.4%	46.6%	13.3%	10%	3.3%	10%	16.8%
Present study	90%/10%	66%	16%	8%	6%	4%	-

[Table/Fig-8]: Showing comparison of present study with other studies on CT urography in urinary obstruction.

for short term as well as long term outcome. MDCT is the most important diagnostic modality in evaluation of urinary tract calculi and has complete replaced excretory urography for this purpose [11,12]. The reasons for these are manifold. While excretory urography may require bowel preparation and suffers from artefacts due to overlapping structures, on the other hand MDCT allows acquisition of true isotropic 3-dimensional images. Unlike radiographs, there are no problems due to overlapping of structures and even small calculi can be confidently visualised and characterised [4,13]. 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. Moreover, MDCT allows direct multiplanar reconstructions and therefore 3-dimensional depiction of stone and even more accurate measurements [14-16].

MDCT also accurately depicts stone burden, stone-skin distance and allows some assessment of stone composition by Housefield density measurement. These factors are helpful in predicting success of Shock Wave Lithotripsy (SWL) with more dense stones typically being less responsive to SWL treatment and may require percutaneous nephrolithotomy or ureteroscopy [17,18].

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 [19-22]. Few recent studies have shown that contrast enhanced high resolution MR urography on 3 Tesla scanners can provide high resolution images of upper urinary tract equivalent to MDCT urography and can also avoid potential radiation exposure with MDCT urograpy but these findings need to be reproduced in larger studies [23,24]. Moreover, MR urography suffers from many disadvantages like longer acquisition times, artefacts and requirement of patient co-operation which may be feasible in acute settings [25]. Till then, MDCT urography remains the proven gold standard.

The results of present study indicate the robust role of MDCT urography as single most useful investigation of obstructive uropathy. MDCT urography with high spatial resolution and real time isotropic multiplanar capability is able to depict accurately the site and cause of obstruction in most cases. Moreover, unlike MR urography, CT urography is able to provide functional information which important for clinical decision making. In case of malignant lesions, it provides simultaneous high resolution imaging for abdominal metastatic lesions which have prognostic implications.

LIMITATION

One of the limitations of present study is small sample size and the fact that many of patients who had deranged renal functions tests who only underwent NCCT were excluded from the study.

CONCLUSION

In conclusion, MDCT urography is one stop shop investigation for evaluation of site and cause of obstructive uropathy. It can be performed rapidly even in unstable patients and provides high spatial and contrast resolution with multiplanar imaging capability. High resolution imaging allows evaluation of any associated complications and metastatic abdominal pathologies and also other significant findings. It can be easily incorporated into CT abdomen protocols by adding excretory phase images in obstructive uropahy patients to get additional functional information.

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