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Original Research Article

The Study is an Attempt to Define the Accuracy of CT Urography Over Ultrasonography

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Abstract:

Aims and Objective: The objective of the study is to define the accuracy of CT urography over ultrasonography and its role in further patient management.

Materials and Methods: A prospective study of 100 patients with urinary symptoms was conducted in a period of 2 years.

Result: In a study of 100 patients, 64% of the patients presented with back pressure changes due to calculus in 42 cases (65.6%), PUJ obstruction in 6(9.3%), stricture in 5(7.8%) and malignant infiltration in 5(7.8%) were seen. There were 14 cases of neoplasms in our study, 7 cases of kidney & urinary bladder each and 9 cases of upper urinary tract infections which included 8 cases of pyelonephritis & 1 case of ureteritis. There were 6 cases of congenital anomalies: 2 cases had congenital pelvi-ureteric junction obstruction, one had medullary sponge kidney with Caroli's disease, two had ectopic kidney, one had retrocaval ureter & one had pyelogenic cyst. A separate category consisting of 6 cases of non-neoplastic urinary bladder pathologies, which included 3 cases of blood clots in urinary bladder and 1 case each of vesical calculus, diverticulum and radiation cystitis.

Conclusion: CT IVU proved to be more sensitive modality for diagnosis and follow-up of renal tract infection, screening for obstruction/ calculi, grading backpressure changes if any and to detect underlying anomalies. It defines the extent of disease and identifies significant complications and obstruction.

Keywords: Urography, Neoplasm, Pyelonephritis.

Introduction

Application of multi–detector row CT for evaluation of urinary tract is termed CT urography. The concept of CT urography is attractive, since both the renal parenchyma and urothelium can be evaluated with a single comprehensive examination. Multidetector CT urography (MDCTU) offers several advantages over excretory urography and ultrasonography in the evaluation of the patient with haematuria.

Materials And Methods

A prospective study of 100 patients with urinary symptomatology was performed who presented. The study was conducted during a period of 2 year

Inclusion Criteria

1. Patients presenting with urinary tract symptomatology.
2. Patients having normal renal function as assessed by Serum Creatinine level & Estimated GFR (eGFR).
3. Patients with good breath-holding capacity.

Exclusion Criteria

1. Patients with renal dysfunction.
2. Allergy to contrast media.
3. Pregnant or lactating women.

Results

Of the 100 patients included in the analysis, 68 were male and 32 were female and the mean age group at presentation was 41-60 years (42 patients).

Most of the patients had more than one complaint. Pain (58%) was the dominant symptom followed by haematuria (8%) & micturition disturbances (6%). History of previous surgery or intervention constituting 16% of cases. Other symptoms (4%) included history of fall, history of CV stroke taking antiplatelets, pain in perianal region & also included one asymptomatic individual kidney were more commonly affected (38%) followed by ureters (34%).

In a study of 100 patients, 64% of the patients presented with back pressure changes due to calculus in

42 cases (65.6%), PUJ obstruction in 6(9.3%), stricture in 5(7.8%) and malignant infiltration in 5(7.8%) were seen. Other cases included Pyelonephritis in 2 (3.1%) associated with ureteric calculi, retrocaval ureter in 1 (1.6%), urinary bladder diverticulum in 1 (1.6%), blood clots in urinary bladder in 1 (1.6%) and post-PCNL urinary leak with residual dilatation in 1 (1.6%). Out of the total 42 cases of calculi, renal calculi were detected in 11 (26.2%) and ureteric calculi in 31 (73.8%). addition, one patient also had urinary bladder calculus without significant back-pressure changes. Out of 42 patients 15 patients (35.71%) had obstructing calculi more than 8 mm, making passage through the urinary tract difficult.

There were 14 cases of neoplasms in our study, 7 cases of kidney & urinary bladder each.

9 cases of upper urinary tract infections were noted which included 8 cases of pyelonephritis & 1 case of ureteritis.

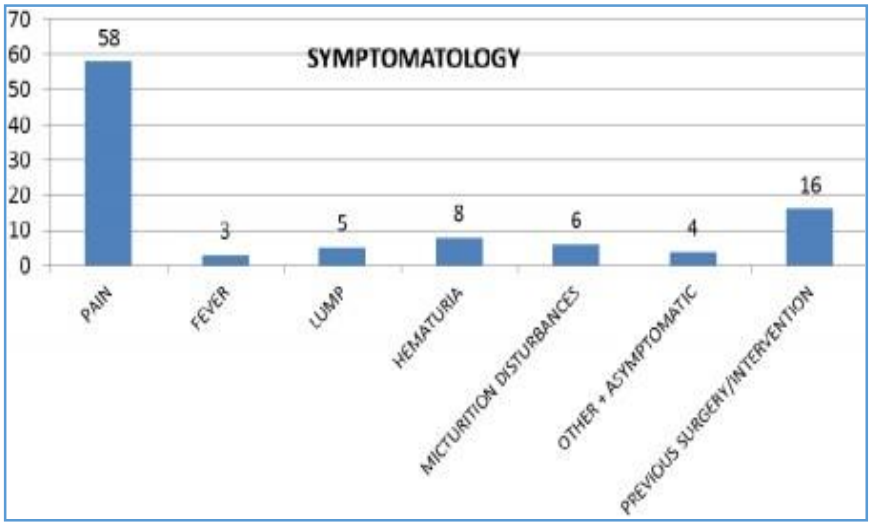
There were 6 cases of congenital anomalies: 2 cases had congenital pelvi-ureteric junction obstruction, 1 had medullary sponge kidney with Caroli's disease, 2 had ectopic kidney, 1 had retrocaval ureter & 1 had pyelogenic cyst.

A separate category consisting of 6 cases of non- neoplastic urinary bladder pathologies, which included 3 cases of blood clots in urinary bladder and 1 case each of vesical calculus, diverticulum, and radiation cystitis.

Incidentally cortical renal cysts were detected in as many as 14 patients. However, those cysts which were clinically significant were seen in 5 patients in our study, out of which 4 had parapelvic cyst and one patient had polycystic kidney disease. In addition, one patient had an obstructing ureteric calculus and was found to have multiple bilateral cortical cysts.

Table 1: Symptomatology

Symptoms	No. of Cases
Pain	58
Lump	5
Hematuria	8
Micturition Disturbances	6
Fever	3
Other Complaints + Asymptomatic	4
History of Previous Surgery/Intervention	16



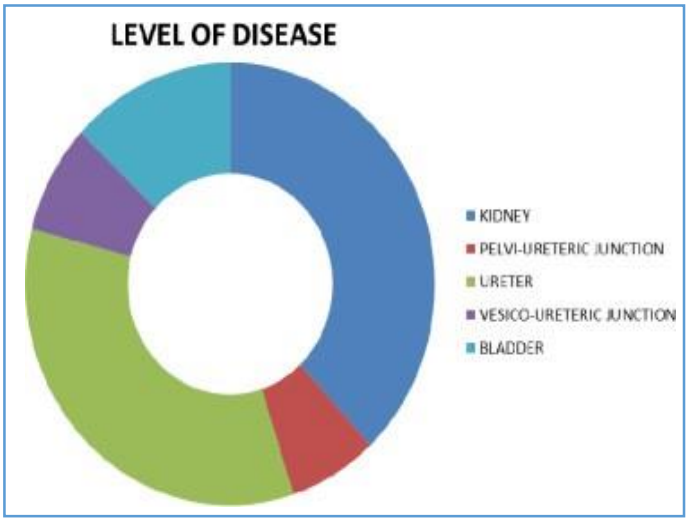
Graph 1: Symptomatology

Table 2: Distribution of various causes

Etiology	No. of Cases
Obstructive	50
Neoplastic	14
Infective	9
Post-Operative/Post-Intervention	7
Congenital	6
Urinary Bladder Pathologies	6
Renal Cystic Disease	5
Extraurinary	3

Table 3: Size of obstructing calculi

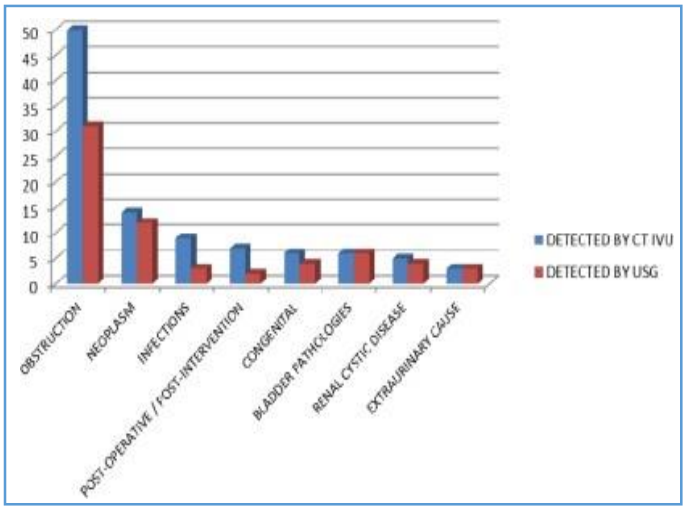
Size	No. of Cases
0-4 mm	17
4-8 mm	10
>8 mm	15



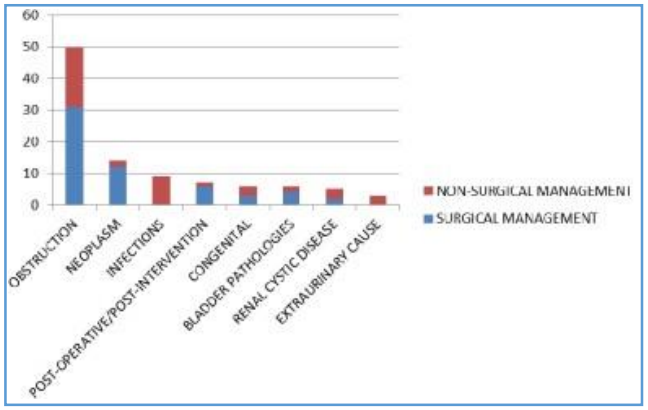
Graph 2: Level of disease

Table 4: Comparison Between USG and CT IVU

Etiology	No. of Cases	Detected by USG	Detected by CT IVU
Obstructive	50	31	50
Neoplastic	14	12	14
Infective	9	3	9
Post- Operative/Post-Intervention	7	2	7
Congenital	6	4	6
Urinary Bladder Pathologies	6	6	6
Renal Cystic Disease	5	4	5
Extraurinary Cause	3	3	3
Total Cases	**100**	**65**	**100**



Graph 3: Comparison between USG and CT IVU



Graph 4: Surgical vs. Non-surgical Management of Various Urinary Tract Disorder

Discussion

In the present study 100 patients with urinary tract symptomatology were included, who underwent CT-IVU. Available pathological and surgical findings were corroborated with the imaging findings. Our study was different from most other studies done on CT urography as it deals with all the urinary tract disorders and not just a specific group of lesions as is done in most studies.

Obstructive Uropathy

This was commonest condition in our study being present in 50 out of 100 patients (50%). However, total patients in which back-pressure changes detected were 64 (64%). These cases included Calculus Disease in 42 (65.6%), PUJ obstruction in 6 (9.3%), stricture in 5 (7.8%), and malignant infiltration of VU junction/lower ureter in 5 (7.8%) cases. Other cases included Pyelonephritis in 2 (3.1%) associated with ureteric calculi, retrocaval ureter in 1 (1.6%), urinary bladder diverticulum in 1 (1.6%), blood clots in urinary bladder in 1 (1.6%) and post-PCNL urinary leak with residual dilatation in 1 (1.6%). Out of the total 42 cases of calculi, renal calculi were detected in 11 (26.2%) and ureteric calculi in 31 (73.8%). In addition, one patient also had urinary bladder calculus without significant backpressure.

Mean age at presentation of calculus disease was 42.4 years. Londsdale [1] also reported it to be common in middle aged patients.

In our study 42 out of 42 (100%) cases had radio-opaque calculi. This is similar to the study done by Eddell Zegel [2] which reported incidence of radio-opaque calculi to vary from 90-95%.

All 42 cases (100%) of calculi were detected by CT IVU. This is the same as shown by the study of Col KK Sen et al [3]. Our study was able to accurately measure the size of obstructing calculi, with 15 cases having calculi >8 mm making them extremely difficult to pass through the urinary tract.

A study was done by Song JH et al, to assess the utility of contrast enhanced CTU in patients with urinary calculi. It was found out that contrast enhanced phase was necessary in 84% of examinations to make out the specific diagnosis because important pathologic changes are seen only after contrast enhanced phase. [4]

Neoplasms

There were 14 cases of neoplasms in our study, 7 each of kidney & urinary bladder. The mean age of renal neoplasms was 58.7 years, while the mean age for bladder neoplasms was 67.5 years.

The sensitivity of detecting neoplasms was 100% for CT IVU. CT has been shown to be more accurate in the detection of parenchymal masses compared to ultrasound or excretory urography with sensitivities of 94% reported compared to 67% and 79% for intravenous urography and ultrasound respectively as shown by the study done by Fielding JR et al [5]. CT can detect upto 47% of masses measuring 5 mm and 75% of masses measuring 10-15 mm and 100% of masses measuring >15 mm in diameter as proved by the study done by Jamis –Dow et al [6].

In retrospective study by Maheswari et al 200 patients underwent CT urography and a sensitivity, specificity and accuracy of 100%, 99%, 99% respectively was obtained for upper urinary tract cancers.[7] Caoili et al [8] reported that 15 of 16 (6 in the renal pelvis and ureters, and 9 in the urinary bladder) proven urothelial malignancies were detected by CT urography. Excretory urography has been reported in the literature to have detection rates for urothelial neoplasms of only 43-64%8.

In the present series all 7 cases of urothelial malignancies of urinary bladder were detected by CT urograph. In a pilot study conducted by Jinzaki M et al, contrast enhanced CT was performed in 59 patients with bladder tumours. CT with Multiplanar Reformation depicted bladder tumours with a sensitivity of 90% and no false positive findings. Therefore, it was concluded that contrast enhanced MDCT shows specificity for the detection of bladder tumours [9].

Infections

There were 9 cases of upper urinary tract infections in our study which included 8 cases of pyelonephritis & 1 case of ureteritis. In addition, cystitis was detected in 7 patients.

CT could correctly detect and define the extent of disease in all the cases of GU infections in our study.

We had 5 cases of infections associated with calculus disease (2 cases of pyelonephritis and 3 cases of cystitis). The underlying cause of infection, i.e. calculi was detected by USG in 4 out of 5 cases. Rest of the cases of cystitis were: One case of radiation cystitis and one case each of urinary bladder diverticulum, blood clot in urinary bladder and infected renal cortical cyst associated with cystitis. Both USG & CT IVU were able to diagnose all these cases. However, USG failed to show ipsilateral lower lung consolidation in a case of pyelonephritis, which was delineated by CT IVU. Our findings were similar to the studies done by Soulenet al [10], Webb. [11] Kaplan et al [12] & Rauschkolb et al [13] who reported CT IVU superior to US in detecting parenchymal abnormalities, delineating disease and detecting perinephric collections.

IVU plays a minor role in the imaging of infection, although it is often requested to screen for obstruction.[14] In 75% of patients with uncomplicated acute pyelonephritis IVU is normal. [8,15] USG in general however, has limited use in the evaluation of genitourinary TB. [16] CT IVU on the other hand, accurately detects calcifications. [16] and can assess perinephric extension. [17,18] Extension to peri- and para-renal spaces.[17] or psoas "cold abscess" may be seen. [18] CT IVU is almost as sensitive as scintigraphy in detecting abnormalities of acute pyelonephritis. [11,13]

Congenital

There were 6 cases of congenital anomalies: 2 cases of congenital pelvi-ureteric junction obstruction, one case of medullary sponge kidney with Caroli's disease, 2 cases of ectopic kidney, 1 case of retrocaval ureter & 1 case of pyelogenic cyst. Both the cases of PUJ obstruction were evaluated by USG & CT IVU and the back-pressure changes were detected correctly. However, only CT IVU was able to provide information on exact level of obstruction, functional aspect and whether the obstruction was complete or incomplete. We also had 2 other cases of incidentally detected congenital anomalies, both of which had bifid renal pelvis.

CT IVU detected all the congenital anomalies, efficacy being 100%. In a retrospective cohort study done by Glodny et al [19] in 209 patients concluded CT IVU as the most reliable imaging method in cases of horseshoe kidneys & crossed fused ectopia. Variousstudies done by McColloughet al [20], Nolte – Ernsting CC et al [21] & Herts BR [22] have shown CT IVU has detected a variety of congenital anomalies of the urinary tract, including partial duplications, complete duplications, ectopic ureteroceles, pelvic kidneys and horseshoe kidneys. Duplications appear to be more conspicuous when image reformatting is obtained [22]. The study done by Lang et al [23] showed congenital ureteropelvic junction anomalies appropriately diagnosed with CT IVU.

Extraurinary

CT urography can be used to depict structures outside the urinary tract and thus is useful in detecting unsuspected extraurinary disease. In one study done by Liu et al [24], extraurinary findings were detected in 259 (75.3%) of 344 patients examined for haematuria with CT urography. 62 (18.0%) patients had highly significant findings, including 3 cancers. In our study there were 3 cases with extraurinary cause for obstructive uropathy. These included pelvic malignancies, one each of prostate & ovarian malignancy as well as one case of recurrent pelvic mass post-hysterectomy. All three cases were detected by CT IVU & USG; however, USG was less sensitive in detecting associated features like pelvic lymphadenopathy, omental nodules, hepatic metastases & urinoma formation due to leak from obstructed pelvicalyceal system.

Post-Surgery / Post-Intervention

This was a separate category comprising 7 patients, out of which 2 cases underwent hysterectomy, two cases underwent DJ stenting, two cases underwent PCNL / Nephrostomy & 1 case underwent pyeloplasty for PU junction obstruction. The cases who underwent hysterectomy recently (1 case underwent abdominal & another laparoscopic hysterectomy) had urinary leak with fluid collection in pelvis. USG was able to diagnose only fluid collection, but CT IVU was able to demonstrate the exact site of rent in the ureter.

According to estimates, 52% to 82% of operative ureteral injuries occur during gynaecologic surgery [25-28]. The ureter is more commonly injured during an abdominal hysterectomy (2.2%) [29-31] than a vaginal hysterectomy (0.03%) [32] and more commonly in an open abdominal hysterectomy than in a laparoscopic hysterectomy (1.3%) [33]. More appropriate studies include an abbreviated IVP or CT with delayed imaging and pyelography (CTIVP). Findings suggestive of ureteral injury include extravasation of contrast, hydronephrosis or nonvisualization of the ureter.

Renal Cystic Disease

Incidentally cortical renal cysts were detected in as many as 14 patients. However, those cysts which were clinically significant were seen in 5 patients in our study, out of which 4 had parapelvic cyst and

one patient had polycystic kidney disease. In addition, one patient had an obstructing ureteric calculus and was found to have multiple bilateral cortical cysts. CT IVU was able to diagnose all the 5 cases of cysts and was also able to detect the presence of incidental cortical cysts in all patients.

In a retrospective study of 16 patients of parapelvic cysts by Hidalgo et al [34], CT was easier and more definitive than sonography alone in distinguishing parapelvic cysts from hydronephrosis or renal sinus lipomatosis.

Urinary Bladder Pathologies

This was included in a separate category consisting of 6 cases of non-neoplastic urinary bladder pathologies, which included 3 cases of blood clots in urinary bladder and 1 case each of vesical calculus, diverticulum and radiation cystitis. Three cases were also associated with changes of cystitis (One case each of vesical diverticulum, vesical calculus & blood clot).

Other Findings

There were 33 cases in which incidental non-obstructing urinary tract calculi were detected on the ipsilateral/ contralateral side of the main pathology. There were 14 cases in which incidental renal cysts were detected. CT IVU was able to detect all these cases. There were 5 cases of extra- renal pelvis including two cases of bilateral extra-renal pelvis. There were 15 other cases which had findings related to the main pathology or incidental finding.

Conclusion

Although all imaging modalities play an important role in imaging the urinary tract, CT urography represents the most comprehensive imaging examination of the urinary tract.

Nearly all stones, including those containing uric acid and those located in unusual positions are detectable by CT IVU. An unenhanced study is highly sensitive and accurate in diagnosing obstruction secondary to ureteric calculi. It is more accurate than ultrasonography in demonstrating the presence, size and location of urinary tract calculi. Furthermore, with contrast administration, excretion function and renal parenchymal changes can be accurately assessed, the biggest advantage over USG.

In cases of neoplasms, whether urinary or extraurinary, CT IVU was found superior and reliable than other modalities. Hence it can be said that, CT IVU is a promising technique in detecting urinary tract neoplasms. CT IVU proved to be more sensitive modality for diagnosis and follow-up of renal tract infection, with USG frequently used to screen for obstruction / Calculi, grade of backpressure changes if any and to detect underlying anomalies as a cause of infection. It defined the extent of disease and identified significant complications and obstruction. The traditional modalities used to assess UTI IVU and USG have given way to CT, which gives better assessment of the renal parenchyma and extrarenal tissues and does not require a functioning kidney. Helical CT and contrast administration allow further dynamic assessment of the kidney.

Congenital anomalies of renal position, number and form are well depicted by CT IVU. With optimum opacification of ureters, partial and complete duplication of the collecting system can be seen on axial source images. Improved z-axis resolution is a welcome consequence of MDCTU and aid in obtainingdiagnostic qualitythree-dimensional reconstructions, particularly in coronal plane. These factors have improved our ability to thoroughly evaluate the urinary tract for variant anatomy. 3D reconstructions can be very useful in the characterization of urinary tract anomalies such as retrocaval ureter, ureteral duplication / bifid pelvicalyceal system or extrarenal pelvis. An advantage of MDCTU in this clinical setting is that MDCTU can depict not only opacified ureters but also unopacified ureters, which cannot be visualized on excretory urography. Variant anatomy can impact on the performance of urological endoscopy and surgery and also on percutaneous intervention.

Detection and mapping of these anomalies is therefore important when planning these interventions and MDCTU improves our ability to accomplish this.

In cases of post-surgery / post-intervention cases, CT urography was found to be more accurate than USG in the diagnosis of post-hysterectomy ureteric rupture, post-DJ stenting subcapsular hematoma and post-PCNL urinary leak / sinus tract. It also helped the operating surgeon in demonstrating the exact site of rent in the ureter.

CT urography can be used to depict structures outside the urinary tract and thus is useful in detecting unsuspected extraurinary disease, especially nodal / distant metastases and thus helping in TNM staging of the neoplasm. MRI currently is limited to patients in whom iodinated contrast medium is contraindicated or in selected patients in whom full assessment cannot be made using other modalities.

MDCTU has the potential to stand alone as a comprehensive “one stop” test for imaging the upper and lower urinary tract.

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