Volume : 5 | Issue : 6 | June 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

Urography : Various imaging Modalities. Is CT Urography the Most Promising Successor of Traditional IVU

Medical Science

KEYWORDS : : Intravenous urography, renal tuberculosis, CT urography, MR urography, imaging modalities

Dr. Garima Sharma	Resident, Department of Radiodiagnosis, Lokmanya Tilak Municipal Medical College and General Hospital, Sion, Mumbai.
***Dr. Swarnava Tarafdar**	Resident, Mahatma Gandhi Institute of Medical Sciences, Sewagram, Wardha, Maharashtra * Corresponding Author
Dr. Suleman Merchant	Professor and Head, Department of Radiodiagnosis, Lokmanya Tilak Municipal Medical College and General Hospital, Sion, Mumbai.

ABSTRACT

The present prospective study of 50 patients aimed at evaluating relative value of the available imaging modalities such as ultrasonography (USG), multidetector computed tomography (MDCT) and magnetic resonance (MR) imaging over intravenous urography (IVU) in evaluation of urinary tract disease. Out of these various modalities, CT Urography (CTU) with three dimensional reformatted images and multiplanar reconstruction proved to be the most promising successor of IVU for the whole range of urological conditions like calculus disease, infections, neoplastic, congenital and traumatic conditions and post-operative complications. MR Urography is still an evolving technique. It has low sensitivity for detecting calcifications and calculi and lacks the spatial resolution of CT but can be used to evaluate the urinary system in a single imaging study without exposure to radiation. USG is an excellent screening modality for diseases affecting the urinary tract. We propose use of CTU over IVU in evaluation of urinary tract pathologies, however IVU cannot still be completely dispensed with in our country where cost is a major factor in deciding the work up of a patient.

INTRODUCTION

Technology in all fields of science has advanced by leaps and bounds. With advancing technology come greater expectations, more choices and better performance. However, with more advancement come greater responsibilities. It is the duty of the radiologist to choose the imaging modality which would give the maximum relevant information in any given case, to choose the most cost-effective imaging modality and to always comply with the principle of ALARA (As Low As Reasonably Achievable) if the workup of a patient requires exposure to radiation.

For decades, intravenous urography has been the primary imaging modality for evaluation of the urinary tract. In recent years, however, other imaging modalities including ultrasonography, multidetector computed tomography and magnetic resonance imaging have been used with increasing frequency in the evaluation of urinary tract disease.(1) USG is undoubtedly a readily available, cost effective, safe, rapid, non invasive , radiation free investigation modality. (2,3,4) But the results are highly operator and interpreter-dependent with large differences in reported sensitivity, specificity and accuracy for various urologic diseases. Large portions of the urinary tract are not easily visualized at USG. MDCT provides the ability to obtain thin (sub-millimeter) collimated data of the entire urinary tract during a short, single breath hold. The resulting thin section images provide higher spatial resolution thus, CT is the test of choice for many urologic problems including urolithiasis, renal masses, urinary tract infection, trauma and obstructive uropathy. However, the increased amount of radiation and the time required for data manipulation are concerns. Magnetic resonance urography (MRU) comprises an evolving group of techniques with the potential for allowing optimal noninvasive evaluation of many abnormalities of the urinary tract. The better contrast resolution and lack of ionizing radiation make MRU a useful technique for evaluating the entire urinary tract, especially when ionizing radiation is to be avoided as in pediatric and pregnant patients. MR imaging provides excellent evaluation of the renal parenchyma for masses and their extensions. (5,6)However, MR imaging is not sensitive in detection of urinary calculi and the lower spatial resolution of MR Urography as compared to CT, which is essential for collecting system evaluation, makes MR Urography a less attractive modality.

MATERIAL AND METHODS

This was a prospective study of 50 patients who presented to the Urologic OPD or Emergency department with suspected urinary tract abnormalities. Standard tests (history taking, physical examination, routine urinalysis with or without cystoscopy and cytology) were directed to all patients, whereas the mode of additional urinary tract imaging (USG or four-phase CT Urography / MR urography) was selected by the Urologist according to a risk-benefit ratio-based management algorithm. Findings were compared with results of urinalysis, cystoscopy and/or ureteroscopy and/or surgery. Prior institutional ethics committee clearance was obtained for the study. Informed consent was obtained from all subjects. The patients underwent an USG scan using 3.75 MHz curvilinear and 7.2 MHz linear transducers on Toshiba Nemio/ Toshiba Xario Color Doppler machine. Color, Spectral and Power doppler were used in patients whenever needed. Based on the findings of the ultrasound scan, the patients were subjected to further investigations, like an IVU, CTU or MRU as the requirement may be. The IVU was performed with Iohexol (Omnipaque) contrast material administration after taking plain film. In adults, a bolus dose of 75 ml of 350 mg% (w/v) was administered and in children, the dose was calculated according to the body weight (ml of 350mg/ml contrast given = Body weight X 1.5).

The CT urography studies were performed on 64 slice MDCT Philips Scanner. Image acquisition: Scans were performed at 120 kV, 200 mAs in all patients irrespective of Body Mass Index. A nominal slice width of 5 mm and detector collimation of 0.625 mm was used. After a plain scan 80 ml of contrast medium (Iohexol 350mg%v/w) was injected at a flow rate of 3 ml/sec with the aid of pressure injector. Arterial phase or the Corticomedullary phase was taken at an interval of 18-22 seconds and venous phase or the Nephrographic phase was taken at an interval of 60-70 seconds from the time of contrast injection. A fast bolus of

200 ml of Normal Saline was given just after the Nephrographic phase to enhance excretion of contrast. Delayed phase or the Pyelographic phase was taken after 3-8 min to assess the excretory function of the kidneys and image the course and caliber of the ureters.

Image reconstruction and post processing: overlapping reconstruction was performed with a slice thickness of 2 mm at 1 mm intervals. 3D reconstruction with thin planar (1mm) MPR was performed in coronal and sagittal planes. In addition, post processing was done to produce MIP (Maximal Intensity Projection) and 3D Volume rendered images.

MR Urography studies were done on a 3 Tesla Philips Achieva machine. Both static fluid and excretory MR Urography were performed in all patients referred for MR Urography except in patients with a GFR<30ml/min or a Sr.creatinine> 2mg/dl when only static fluid MR Urography was done. Patients were given an intravenous injection of 10 mg furosemide and were asked to void just before the start of examination. A phased array body coil was used for imaging. Respiratory gating was routinely used in all patients.

The contraindications for IVU and CTU included those patients having contraindication for radiation exposure like pregnant patients and those having contraindication for contrast injection like history of allergy or previous contrast reaction and patients with deranged serum creatinine levels. The use of compression technique during IVU was not done in patients with history of recent abdominal surgery, ureteric calculus and in paediatric patients. MR Urography was not performed in patients with general contraindications to MRI like implanted cardiac pacemaker or defibrillator, patients with brain Aneurysm Clip, implanted neural stimulator, cochlear Implants, ocular foreign body, other implanted medical devices (eg. Swan Ganz catheter) and insulin pump and also in patients with metal shrapnels or bullets. Contrast MR Urography with gadolinium was avoided in lactating women, patients with hemoglobinopathies, patients with moderate to severe renal insufficiency (i.e. with GFR<30ml/min or a S. creatinine> 2mg/dl) to avoid development of Nephrogenic Systemic Fibrosis. Good oral hydration for atleast two days prior to examination was ensured to minimize effects of intravenous contrast on renal function. A mild laxative like Tab Cremalax was usually prescribed, to be taken at night before the scheduled date of procedure. Patients were asked to consume nothing by mouth for atleast 6 hours prior to the examination. Patient's Blood Urea Nitrogen and Serum Creatinine levels were checked prior to start of procedure.

RESULTS

A total number of 50 patients were included in the study referred from the Urology OPD or Emergency casualty room. Based on the USG findings, further laboratory investigations and imaging studies like Conventional Urography, CT Urography and/or MR Urography were planned. The clinical presentations are depicted in Table 1. In this study of 50 patients, 34(68%) patients were males and 16(32%) were females. The age group distribution and age of presentation of various pathologies are shown in Figure 1 and Table 2 respectively. The distribution of diseases and indications of various urographic studies are shown in Tables 3 and 4 respectively. Selected USG, IVU, CTU and MR Urography images of various urinary pathologies are depicted in Figure 2 to Figure 35.

Table 1: Clinical presentation

Sr no.	Clinical Presentation	No. of patients
1	Pain in abdomen	12(24%)
2	Pain in flanks	10(20%)
3	Hematuria	8(16%)
4	Pyuria	4(8%)
5	Fever	4(8%)
6	Retention of urine	2(4%)
7	Chyluria	2(4%)
8	Dysuria & Frequency	2(4%)
9	Recurrent UTIs	2(4%)
10	Urinary incontinence	2(4%)
11	Asymptomatic / Post-op / Follow up	2(4%)

Figure 1: Age Group distribution

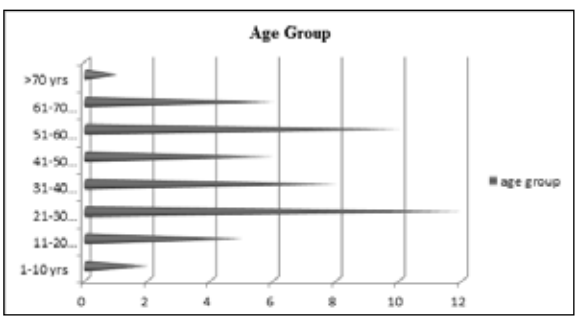


Table 2: Age of presentation of various urinary pathologies

Sr. no.	Diseases & Conditions	Age group at presentation							
		1-10	10-20	20-30	30-40	40-50	50-60	60-70	>70
1	Congenital	2	2	5	3	0	0	0	0
2	Infectious	1	1	2	1	1	2	0	0
3	Calculus disease	0	2	3	0	2	2	0	0
4	Neoplastic								
	Benign	0	0	1	0	1	0	0	0
	Malignant	1	0	0	0	2	4	3	1
5	Traumatic	0	0	3	0	1	0	0	0
6	Post-op & Miscellaneous	0	0	2	0	2	0	0	0

Table 3: Distribution of diseases

Sr. no.	Congenital and developmental abnormalities	No. of patients
1	Horseshoe kidney	2
2	Ectopic kidney	2
3	Malrotated kidney	2
4	Duplicated renal system	2
5	Ureterocele	2
6	Retrocaval ureter	1
7	Pelviureteric junction obstruction	2
8	Autosomal Dominant Polycystic Kidney Disease	1
9	Autosomal Recessive Polycystic Kidney Disease	1
10	Vesico-ureteral reflux	1

Sr no.	Neoplastic (Benign and Malignant conditions)	No. of patients
1	Renal cell carcinoma	3
2	Transitional cell carcinoma	3
3	Wilms'tumour	1
4	Angiomyolipoma	2

Volume : 5 | Issue : 6 | June 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

5	Lymphoma	1
6	Squamous cell carcinoma	1
7	Complex renal cyst	1

Sr. no.	Infectious and inflammatory	No. of patients
1	Acute Pyelonephritis	1
2	Emphysematous pyelonephriris	1
3	Genitourinary Koch's	3
4	Renal abscess	2

Sr no.	Calculus disease	No. of patients
1	Renal calculi	2
2	Staghorn calculi	1
3	Ureteric calculi	2
4	Uretero-vesical junction calculi	1
5	Bladder calculi	1

Sr. no.	Post-op and miscellaneous conditions	No. of patients
1	Neobladder with ureteric reimplantation	1
2	Vesicovaginal fistula	2
3	Urethrovaginal fistula	1

Sr no.	Traumatic conditions	No. of patients
1	Traumatic	3
2	Iatrogenic	1

Table 4: Indications for various Urographic studies:

Sr. no.	Indications	Modality used for imaging		
		IVU	CTU	MRU
1	Suspected Calculus disease	6	4	0
2	Suspected Congenital abnormalities	5	6	2
3	Suspected Benign neoplasms	0	1	1
4	Suspected Malignant neoplasms	0	10	5
5	Suspected Acute infections	0	3	0
6	Suspected Koch's	3	3	3
7	Suspected Urinary fistulas / leaks	1	2	0
8	Traumatic injuries	0	2	0

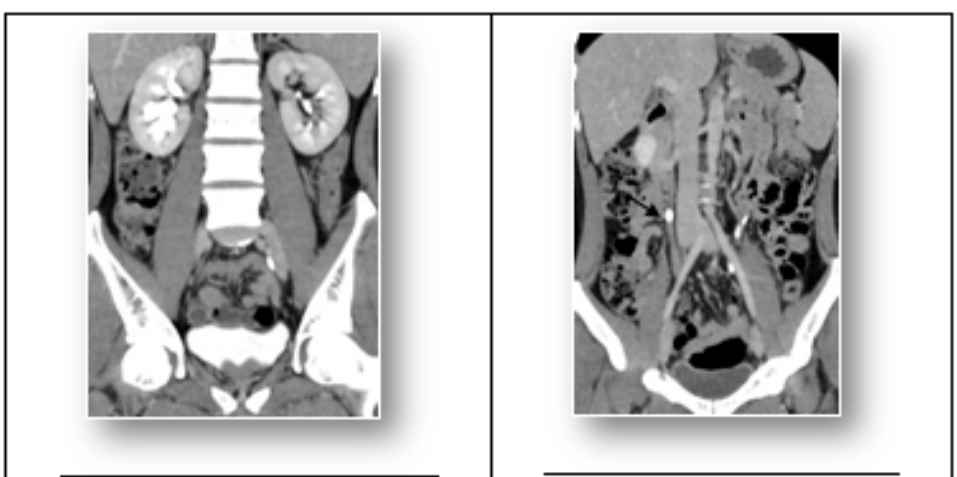


Fig 2 & 3: Coronal reformatted images of nephropyelographic phase of CT Urographic study done using the 'Split-bolus technique', showing mild right hydronephrosis and a right ureteric calculus (black arrow).

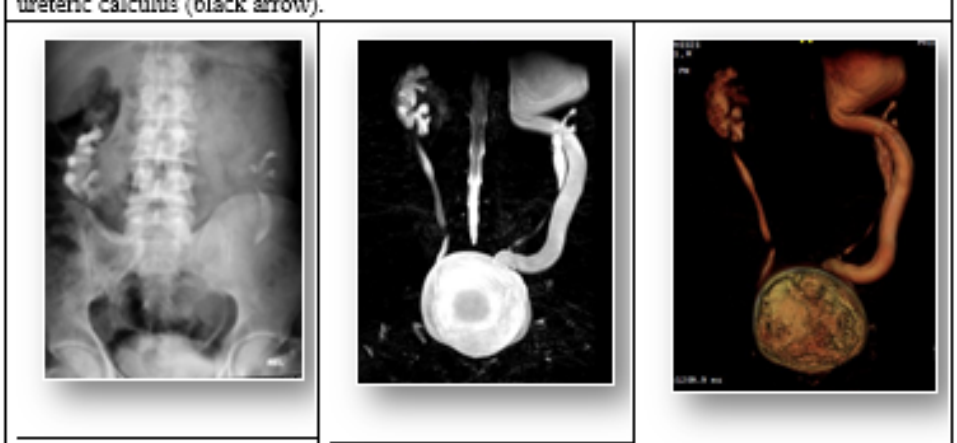
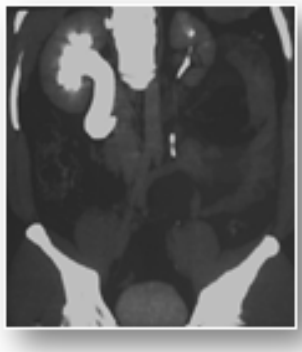


Fig 4: Release film from IVU series shows duplex left system with the opacified lower pelvicayceal system of the left kidney with complete duplication of ureter with an obstructed, non-opacified, hydronephrotic upper moiety and a moderately dilated upper moiety ureter which was confirmed in CTU. Part of contrast opacified lower moiety ureter is seen. The right kidney is malrotated with tortuous course of right ureter. Fig 5 & 6: Static fluid and 3D Volume rendered MR Urographic images of the same patient showing details of IVU more clearly.



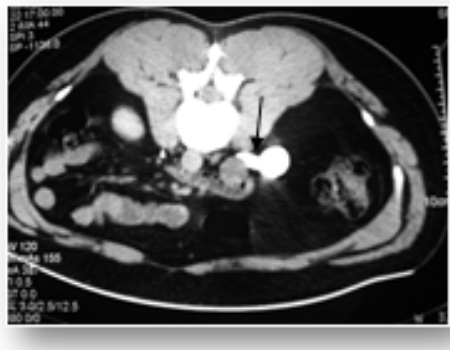
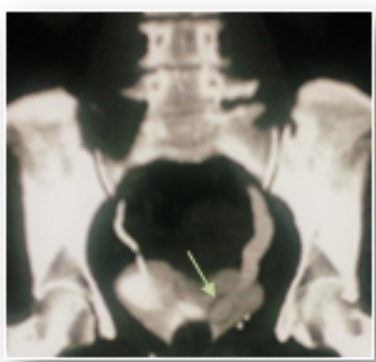


Fig 7 & 8: Maximum Intensity Projection (MIP) and axial excretory phase images from a CTU study showing moderate hydronephrosis and proximal hydroureter on the right side with mild acute medial deviation of mid ureter, beyond which the ureter is not opacified. Axial prone excretory phase image shows the dilated right ureter (black arrow) going posterior to the IVC. This was a case of retrocaval ureter with obstruction.



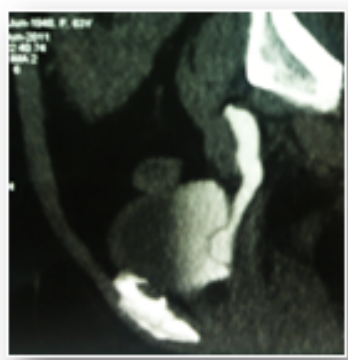
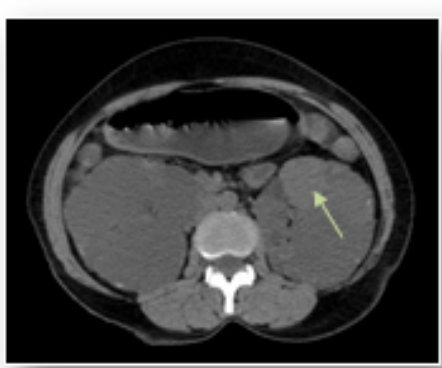


Fig 9 & 10 : Coronal and sagittal MIP images from a CT Urography study showing an orthotopic ureterocele (arrow) on left side giving a "Cobra head appearance" due to surrounding opacified urine in the urinary bladder.



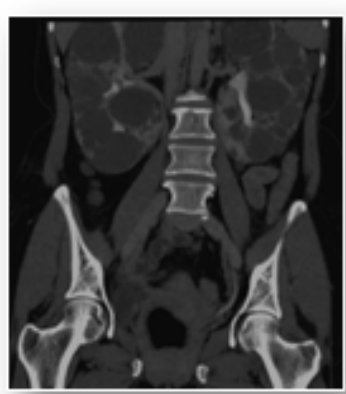


Fig 11 & 12: Axial unenhanced image from a CT Urography study showing enlarged kidneys with multiple cysts within. One of the cysts shows hyperdense contents on plain scan s/o hemorrhage (arrow). Coronal MIP reconstructed image of pyelographic phase shows thinned out and stretched pelvicalyceal system giving a "spider leg" appearance. A case of Autosomal Dominant Polycystic Kidney Disease .

Volume : 5 | Issue : 6 | June 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

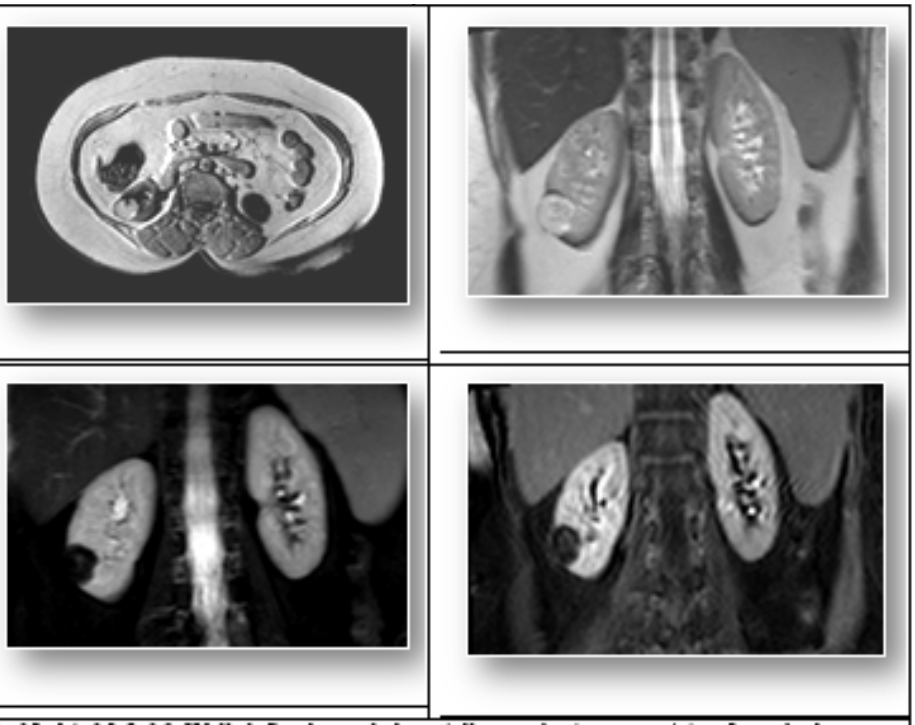


Fig 13, 14, 15 & 16: Well-defined rounded partially exophytic mass arising from the lower part of right kidney which appears hyperintense on both T1 and T2-W images, gets suppressed on T2-SPAIR (fat-sat) sequence and shows no significant enhancement on post-contrast sequence. This is a Renal Angiomyolipoma.

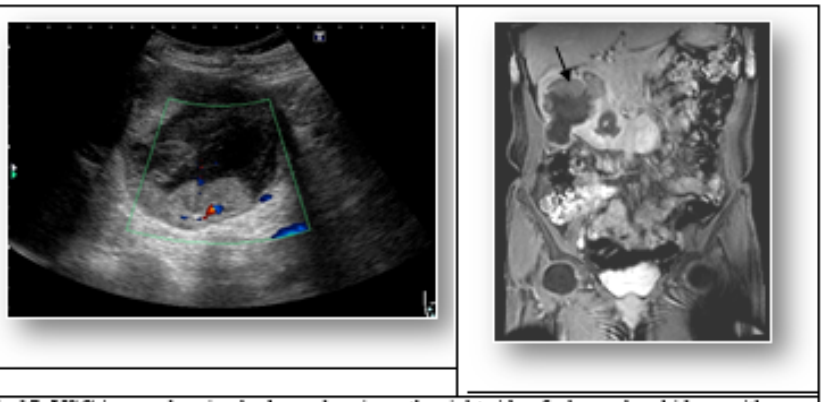


Fig 17: USG image showing hydronephrosis on the right side of a horseshoe kidney with irregular urothelial growth within, showing mild vascularity. Fig 18: Coronal Post Gadolinium T1-W image showing mildly enhancing feathery urothelial growth within pelvicalyceal system on right side of a horseshoe kidney (arrow). This was a case of Transitional Cell carcinoma in a horseshoe kidney.

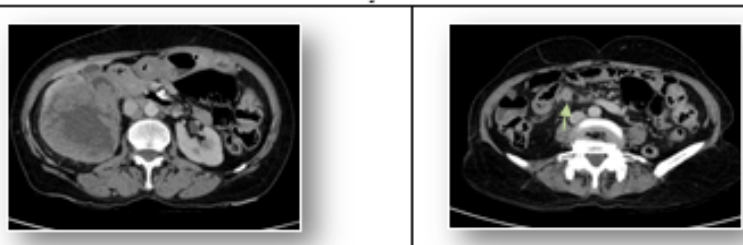
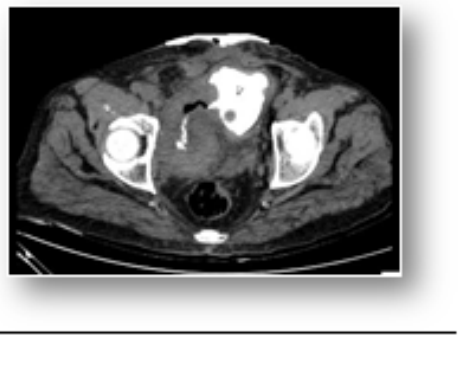


Fig 19 & 20: Axial nephrographic phase CT images of the same patient showing extensive feathery urothelial thickening in the dilated collecting system of right moiety of horseshoe kidney. The right ureter also shows wall thickening with peri-ureteric fat stranding (arrow). There was super-added infection in this case of Transitional Cell Carcinoma.



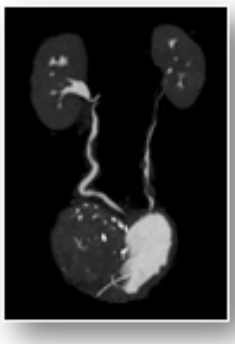
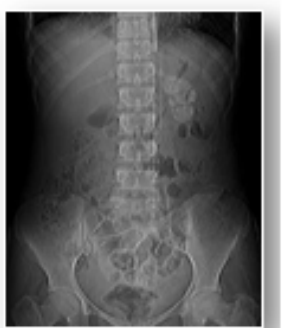
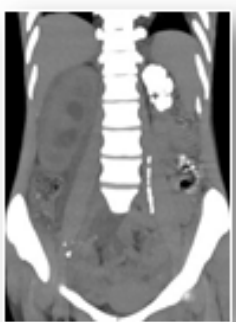


Fig 21: Axial excretory phase CT image showing contrast opacified bladder with thickened walls communicating posterolaterally on the right side with a large soft tissue density lesion. The bladder was shifted anterolaterally by this mass. This was large bladder diverticulum with malignant transformation. Fig 22: Coronal MIP CT Urographic image showing the large mass displacing the bladder towards the left.





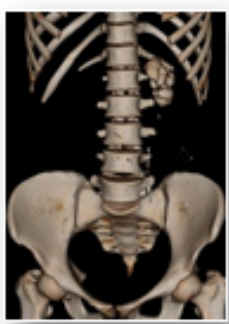
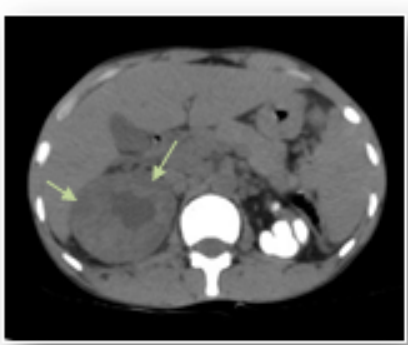


Fig 23, 24 & 25: Scout film (Topogram), MIP and 3D-Volume Rendered images from a Plain CT study, showing Lobar calcifications in the left kidney with linear left ureteric calcification in a patient with Renal Koch's.



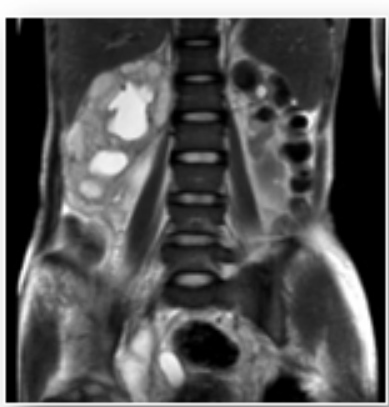


Fig 26 & 27: Axial plain CT image of the same patient showing multiple peripherally located hypodense lesions (arrows) on right side most like s/o multiple subcapsular abscesses with moderate right hydronephrosis. Lobar calcification is noted in left kidney. Only plain study was done as patient's Serum creatinine levels were high. These findings on right side were clearer in Coronal T2-W MRI images without administration of any contrast, showing multiple subcapsular abscesses and moderate right hydronephrosis. The left kidney is replaced by multiple lobar calcifications i.e. putty kidney.

Volume : 5 | Issue : 6 | June 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

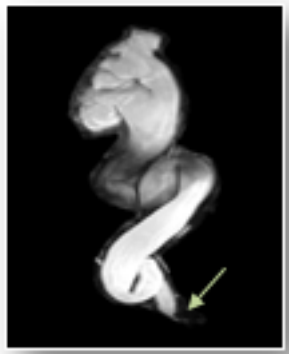


Fig 28: Volume Rendered Static fluid MR Urographic image of the same patient showing moderate right hydronephrosis and hydroureter. The distal most portion of the ureter just before the uretero-vesical junction showed abrupt tapering, probably due to a stricture (arrow).

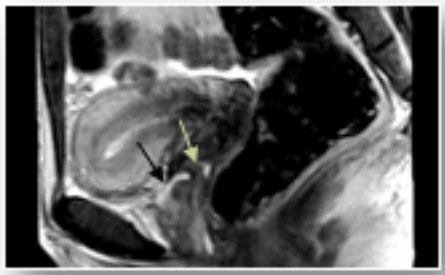
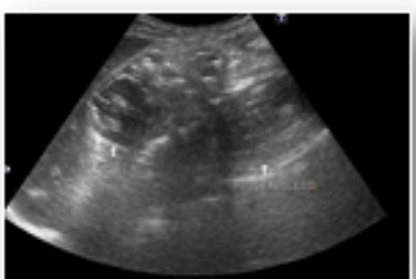


Fig 29: Sagittal MR image of the same patient showing a very small capacity bladder (black arrow) with a thin communication between the vagina and bladder (white arrow) s/o a vesicovaginal fistula. The pateint had complaint of urinary incontinence.



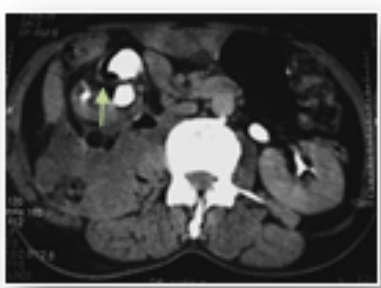
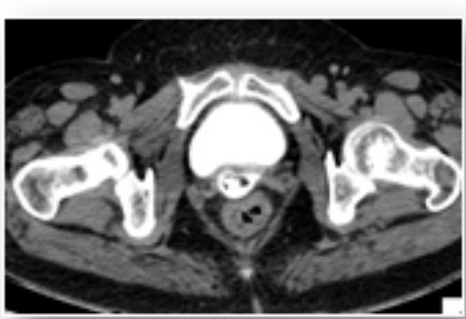


Fig 30: USG image showing multiple air specks in the right renal pelvicalyceal system producing "dirty" shadowing with a psoas abscess noted posterior to the kidney. Fig 31: Pyelographic phase image of a CT urography study showing the right kidney displaced anteriorly by a large abscess in the posterior paranephric space and right psoas. Air is noted along with excreted contrast (arrow) in the pelvicalyceal system of the right kidney and in perinephric space, suggestive of extensive infection. This was a case of Emphysematous Pyelonephritis in a diabetic patient.



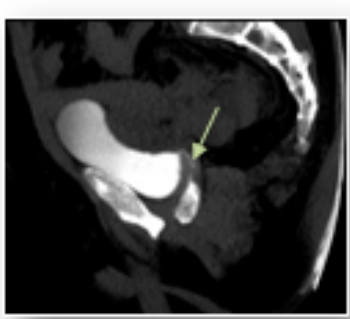
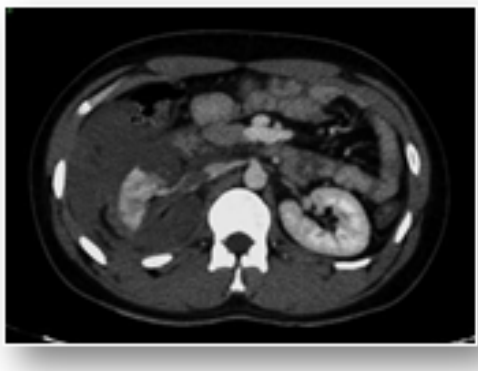


Fig 32 & 33: Axial Excretory phase and Sagittal MIP images from a CT Urography study showing opacification of the vagina by excreted contrast in bladder. Sagittal MIP reconstructed image shows the fistulous tract (white arrow).



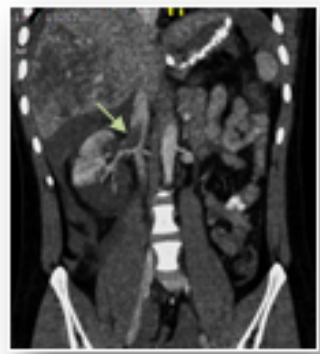


Fig 34 & 35: Axial and Coronal nephrographic phase CT images in a patient of blunt abdominal trauma, showing peri-renal hematoma with non-enhancement of the lower pole of right kidney s/o infarction due to thrombosis of the right renal vein extending into the IVC (arrow) s/o Grade 4 renal injury. The right renal artery however was intact. Also seen were multiple liver contusions-lacerations with mild peri-hepatic fluid.

DISCUSSION

Conventional Intravenous Urography has been the cornerstone of urological imaging for a long time. However, with the advent of CT and MRI, Intravenous Urography is slowly being phased out by these newer modalities for various urological conditions. In our study of 50 patients, the presenting ages of all 12 patients with various congenital and developmental conditions were between the first and fourth decades of life. Most patients with malignancies like Renal cell carcinoma (RCC) and transitional cell carcinoma (TCC) presented beyond the fifth decade of life, excepting one patient with Wilms' tumour who presented in the first decade. Patients with infectious and calculus disease had a wide age distribution. Three (75%) out of 4 patients with traumatic injuries included in our study were in their third decade. In congruence with a study by RA Santucci et al (2004) in which the mean age of presentation of renal trauma patients was found to be between 20 to 30 years.(7)

MDCT urography enables a comprehensive evaluation of patients with renal fusion anomalies in a single examination. Especially three-dimensional reformatted images can provide good delineation of congenital anomalies of the kidney. MR imaging has a limited but increasing role. It is particularly useful in those with iodinated contrast allergies, offering an ionizing radiation free alternative in the diagnosis of both medical and surgical diseases of the kidney. (8,9)

Although most of the abnormalities like horseshoe kidneys, ectopic kidneys, PUJ obstructions etc. were seen on IVU, CT helped in better delineation of the abnormalities. In Autosomal Dominant Polycystic Kidney Disease (ADPKD), IVU showed enlarged kidneys with stretched, thinned out pelvicalyceal system, due to mass effect of the cysts, while multiple cystic lesions of ADPKD were directly seen well on CT. CT also aided in detecting complications like haemorrhage, rupture or infection. In 2004, Michael M. Maher et al, in his study stated that, most congenital anomalies of urinary tract can be appreciated with CTU.(10)

In conditions like retrocaval ureter, IVU depicted evidence of obstruction in the form of hydronephrosis and upper hydroureter, the exact cause of obstruction was confirmed on CTU with the ureter seen going posterior to the IVC. Also, three dimensional reformatted images and multiplanar reconstruction capabilities of Multislice CT provided excellent images of the variant anatomy. Variant anatomy has impact on the performance of urological endoscopy and surgery and also on percutaneous interventions.

MDCT urography is helpful to screen for the presence of stones, hydronephrosis or masses. Additionally, it provides information about the vascular supply of kidneys. 3D reconstructions can be very useful in the characterization of urinary tract anomalies such as ureteral duplication and ectopic ureter or ureteroceles.(10) An advantage of CTU in this clinical setting is that CTU can depict not only opacified ureters but also non-opacified ureters, which cannot be visualized on excretory urography. USG also has limitations in depicting the whole length of ureter

In our study, the entire ureters were demonstrated in 5 (42%) of the 12 (n=12) patients on heavily-T2 weighted MRU and in 9 (75%) patients on Excretory MRU. This was less than that found in a study of congenital urinary tract dilatation by Wiltrud K. Rohrschneider et al, in 2002, by combined static-dynamic MR Urography.(11) They found that the urinary tract was depicted entirely, including the complete ureters and ureterovesical junctions, in 44 (86%) of 51 normal kidney-ureter units and in 67 (74%) of 90 abnormal kidney-ureter units. This difference is probably because in our study, 6(50%) out of the 12 patients who underwent MRI had non-dilated systems.

In our study, five patients (10%) suspected of having acute upper urinary tract infections, including acute pyelonephritis, renal abscesses, emphysematous pyelonephritis and pyonephrosis on intial ultrasonographic examination were referred for further evaluation with a CT Urography study. CT helped in confirming the diagnosis and getting additional information about the severity and extent of inflammation and thus, in prognosticating individual cases. Browne RF et al, in 2004, stated that intravenous urogram and ultrasound have limitations in the evaluation of renal inflammation and infection in the adult.(8) Contrast enhanced CT is a more sensitive modality for diagnosis and follow-up of complicated urinary tract infection

In renal tuberculosis, CTU scored over IVU in detecting the parenchymal affections, like parenchymal calcifications, cortical scarring, focal abscesses etc. In addition, CT helped in detecting other abnormalities attributable to tuberculosis

Volume : 5 | Issue : 6 | June 2016 • ISSN No 2277 - 8179 | IF : 3.508 | IC Value : 69.48

like enlarged lymph nodes, peritoneal and bowel involvement. Michael Gibson et al, in his article stated that, CT is helpful in determining the extent of renal and extrarenal spread of disease.(12) CT is the most sensitive modality for identifying renal calcifications, which occur in over 50% of cases of genitourinary tuberculosis.(13) However, CT is not as sensitive as excretory urography in the detection of early urothelial mucosal changes.(11,13)

MRI also showed the parenchymal abnormalities well, but lacked the spatial resolution of CT. Small calcifications were not very well demonstrated on MRI. The T2-weighted sequence was especially helpful in characterizing cysts and intraparenchymal abscesses and in evaluating hydronephrosis. The advantage of MRU over IVU was that even non-functioning systems (in two patients) could be evaluated with static fluid, heavily T2-weighted MRI, which was not possible with IVU.

In all 13(26%) patients with suspected neoplasms , CT showed the exact localization of tumor and its relation and mass effect on the surrounding structures and the kidneys, involvement of the renal sinus and pelvicalyceal system (on pyelographic phase images), extension into vascular structures like the renal veins and Inferior vena cava (in 1 patient), presence of calcifications and necrosis, presence of neovascularity, presence or absence of accessory renal arteries (on arterial phase images), presence of synchronous tumors in cases of TCC etc. MRI was done in a small subset (4, 30%) of patients for further tissue characterization. Dynamic Post-Gadolinium T1-weighted fat suppressed images further helped in lesion detection and characterization. However, in our study, MRI did not provide any significant extra information over CT in terms of detection and delineation of spread of tumour.

The plain pre-contrast phase of CT Urography study helped in detecting and precisely localizing the calculi, followed by post-contrast cortico-medullary, nephrographic and pyelographic phases which gave some indication of any impairment in renal function. A useful indirect sign of acute obstruction on CT was presence of peri- renal or peri-ureteric fat stranding. Kluner et al. reported that ultra-low-dose CT (0.5 mSv in men and 0.7 mSv in women)—with doses equivalent to that of radiography—had a sensitivity and specificity for the detection of urinary tract calculi of 97% and 95%, respectively.(14)

In the setting of traumatic injuries, CT was accurate in the depiction of parenchymal injuries, peri-renal hematomas, injuries to the renal collecting system, ureters and bladder (by depicting extravasation of excreted contrast), injury to renal pedicle and in grading of renal injuries by the AAST (American Association for the Surgery of Trauma) renal injury severity scale to decide the line of management. CT also helped in detecting other associated solid organ and bony injuries. Traditional IVP should not, in general, be used in the urgent evaluation of renal trauma. R.A. Santucci et al, in 2004, reviewed all papers on renal injury published between 1966 and April 2002 and showed that CT accurately identifies vascular injury, parenchymal laceration, urinary extravasation and perirenal hematoma.(7)

In the 3 patients with vesicovaginal and urethrovaginal fistulae included in our study, CT Urography helped to accurately demonstrate the fistulous tract between the bladder/urethra and vagina. The MIP, MPR and 3D-Volume Rendered techniques are all helpful to depict the exact site of leak or fistula. Chen Liang et al, in a study of 15 patients to evaluate the clinical applications of MDCT Urography in urine leakage, in 2007, concluded that multi-slice CT urography (MSCTU) examination clearly shows the site of urine leakage and other complications and it can be used as the preferred diagnostic modality in cases of urinary leakage.(15)

CONCLUSION

From our study, we thus conclude that each modality of imaging has its own role to play in different urological conditions. USG is an excellent screening modality. Although CT Urography seems to be the promising successor of IVU for almost the whole range of urological conditions like calculus disease, infections, neoplastic, congenital and traumatic conditions and post-operative complications, conventional excretory Urography cannot still be completely dispensed with in our country where cost is a major factor in deciding the work up of a patient.

MR Urography is still an evolving technique but is exciting because it can be used to thoroughly evaluate the renal parenchyma, the pelvicalyceal system and the rest of the urinary tract in a single imaging study without the exposure to radiation. However, in future, further optimization of 3-Tesla Protocols for MR Urography is required for improvement in spatial resolution and to reduce acquisition time and motion artifacts.

REFERENCES

1. Dyer,R.B.,Chen, M.Y., & Zagoria, R.J.(2001). Intravenous Urography :Technique and interpretation. RadioGraphics, 21,799-824.
2. Tarafdar, S., Malhotra, A.,& Tayade, A.(2015). Diagnostic efficacy of Color Doppler combined with Gray scale ultrasonography over Modified Alvarado score for diagnosing appendicitis. Sch. J. App. Med. Sci., 3(8D),3026-3035.
3. Malhotra, A.,Tarafdar, S., & Tayade, A.(2016). Benign versus malignant adnexal masses: Does addition of Color and Spectral Doppler over and above the Gray Scale Ultrasound improves efficacy? Sch. J. App. Med. Sci., 4(1A), 62-74.
4. Tarafdar, S., Malhotra, A.,& Tayade, A.(2016) Acute Abdomen: Role of Ultrasonography in Differentiation of Common Clinical Mimics of Appendicitis. GJRA, 5(4), 20-23.
5. Joffe,S.A., Servaes,S., Okon,S.,& Horowitz, M. (2003). Multi–Detector Row CT Urography in the Evaluation of Hematuria. RadioGraphics, 23, 1441-1455.
6. Blandino, A., Gaeta, M., Minutoli, F., Salamone, I., Magno, C., Scribano, E., & Pandolfo, I.(2002). MR urography of the ureter. AJR Am J Roentgenol, 179, 1307–1314.
7. Santucci,R.A.,Wessells,H.,Bartsch,G.,Descotes,J.,heyns,C.F., McAninch,J.W.,… Schmidlin, F. (2004). Evaluation and management of renal injuries: consensus statement of the renal trauma subcommittee. BJU International, 93, 937–954.
8. Browne, R.F., Zwirewich, C., & Torreggiani, W.C.(2004). Imaging of urinary tract infection in the adult. Eur Radiol,14 Suppl 3,E168-183.
9. Tarafdar, S., & Tayade, A.(2015). MRI evaluation of CVJ anomalies: Report of 7 cases. Sch J Med Case Rep, 3(3), 228-232.
10. Maher,M.M.,Kalra,M.K., Rizzo,S., Mueller,P.R., & Saini,S.(2004). Multidetector CT Urography in Imaging of the Urinary Tract in Patients with Hematuria. Korean J Radiol, 5(1), 1–10.
11. Rohrschneider, W.K., Haufe, S., Wiesel, M., Tönshoff, B., Wunsch, R., Darge, K., …Tröger, J. (2002). Functional and morphologic evaluation of congenital urinary tract dilatation by using combined static-dynamic MR urography: findings in kidneys with a single collecting system. Radiology, 224(3), 683-694.
12. Gibson,M.S.,Puckett,M.L.,& Shelly, M.E. Renal Tuberculosis. (2004). RadioGraphics, 224,251–256.
13. Leder, R.A., & Low, V.H.(1995). Tuberculosis of the abdomen. Radiol Clin North Am, 33,691–705.
14. Kluner, C., Hein, P.A., & Gralla, O.(2006). Does ultra-low-dose CT with a radiation dose equivalent to that of KUB suffice to detect renal and ureteral calculi? J Comput Assist Tomogr, 30 , 44–50.
15. Liang,C., Qiu-xia,W., & Dao-yu, W.(2007). Clinical application of multi-slice spiral CT urography in urine leakage. Journal of Clinical Radiology, 11.