Original Article

Correlation and comparison of CT Urography and non contrast MR urography in evaluation of non-neoplastic urinary tract lesions- A study of 32 patients

Makada MT[1], Thummar KK[1]

[1]Department of Radiodiagnosis, Shri M.P. Shah Govt Medical College & GGH Jamnagar, Gujarat, India.

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ABSTRACT

Background: Nowadays conventional X rays and IVU has been replaced by cross sectional imaging like CT scan and MRI largely. MRI is having advantage of no risk of ionizing radiation.

Aims and objective : To evaluate the role of Multi Detector Computed Tomography and non contrast Magnetic Resonance Imaging Urography in assessment of different non neoplastic urinary tract diseases like congenital lesions, cystic lesions, obstruction by stone & Urinary Tract Infection (UTI).

Material and method: Selected patients underwent CT urography in 16 slice CT scan machine and non contrast MR urography in 1.5 T 16 channel MRI machine.

Results: Total 32 patients scanned from December, 2013 to December, 2015 out of which few patients are having multiple lesions. 25 % patients are having congenital anomalies both in CT and MRI. 46% patients are having calculus disease in CT scan and 43% patients are having calculus disease in MRI. Cystic lesions are detected in 6% of patients in CT scan and 18% patients in MRI. Infection is present in 31% of patients in both CT and MRI.

Conclusion: CT urography is better technique for detection of calculus disease and non contrast MRI is better technique for cystic disease.The numbers of patients with diagnosis of infection and congenital lesions remain same in both CT scan and non contrast MRI.

Key words: CT urography, non contrast MR urography, stone, uropathy, obstruction

INTRODUCTION

Early uroradiology techniques were based on the plain abdominal film and were, for the most part, performed for the evaluation of calculus disease [1]. Subsequently, retrograde pyelography was developed. Retrograde pyelography represented the first imaging study in which contrast material was used to depict anatomy and structural abnormalities [2].

In 1930, Moses Swick, an urologist, developed the first safe intravenous contrast material, Uroselectan [3]. With further advancements in the composition of iodinated contrast material in the 1950s and 1960s, the modern intravenous urogram evolved [4]. Initially, linear tomography of the kidneys or nephrotomography was added if a renal parenchymal lesion was suspected, and arteriography was performed when the mass was suspicious. In the 1980s and 1990s, CT quickly emerged as a powerful tool in the diagnosis of many diseases of the urinary tract. CT also outperformed other imaging modalities in the diagnosis of congenital lesions, renal infection and calculi. In the late 1990s, MRI became an important modality in the diagnosis of urologic disease, especially in patients with renal insufficiency and in patients with an allergy to iodinated contrast media. CT could be used to evaluate all major anatomic segments of the urinary tract.

Improved z-axis resolution is a welcome consequence of CT and aid in obtaining diagnostic quality three-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. An advantage of CT urography in this clinical setting is that CT urography can depict not only opacified ureters but also unopacified ureters, which cannot be visualized on non contrast MR urography.

Anatomy of kidneys

Gross appearance – Kidneys lie retroperitoneally in the paravertebral gutters of the posterior abdominal wall along the lateral borders of psoas muscles. They lie obliquely with their upper poles more medial and more posterior than lower. The extent is from upper border of L1 vertebra to lower border of L3 vertebra. On longitudinal section, kidney is made up of outer cortex, central medulla and internal calyces and pelvis. Extensions of cortex centrally as columns of Bertin separate the medulla into pyramids whose apices jutting into calyces are called papillae. Medulla consists of collecting tubules which drain into minor calyces.

The Collecting system of urinary tract comprises of upper urinary tract, which consists of main urinary outflow conduits from the kidney (renal calyces, renal pelvis and ureter). The lower urinary tract consists of urinary bladder and urethra (This separation is arbitrary).

Anatomy of ureters

Ureters are muscular tubes that course from renal pelvis to bladder in retroperitoneum whose peristaltic waves convey urine from the kidneys to the urinary bladder. Adult ureter measures 25 – 30 cm in length and is thick walled, narrow and continuous superiorly with the funnel shaped renal pelvis. The ureteric diameter is about 3 mm and it has three constrictions along its course. 1) Where the renal pelvis joins the ureter. 2) At the pelvic brim where it crosses the iliac vessels 3) where it traverses the vesical wall (narrowest part). These constrictions (stricture mimics) should be interpreted with care.

Anatomy of urinary bladder

The urinary bladder is a hollow muscular organ and is solely a reservoir of urine. It varies in size, position, shape and relations, according to its content and the state of the neighboring viscera. The ureters enter the posterolateral angles and urethra leaves inferiorly at the narrow neck which is surrounded by internal urethral sphincter. Perivesical fat surrounds the bladder. Superiorly it is loosely covered by peritoneum, which separates it from loops of small bowel and sigmoid colon.

The bladder is an extraperitoneal structure. It is entirely in the pelvis but as it distends it expands anterosuperiorly into the abdominal cavity. Adult bladder has a capacity of 350-450ml.

MATERIALS AND METHODS

Sample size, study area& duration of study: Total 32 patients were selected for present study. Patients were coming at M.P.shah medical college and G.G.Hospital, Jamnagar, Gujarat from December, 2013 to December, 2015.

Methodology: Patients are selected for this study who presented with clinical symptoms and signs pertaining to urinary tract diseases. Results checked by two radiologist and final comparative data given between Magnetic Resonance Imaging and Computed Tomography Urography with counting risk factor of ionizing radiation and intra venous contrast toxicity.

Description of tools:

Clinical: All the patients were subjected to detailed clinical history and examination**.**

Investigation: Routine blood investigations were documented in needy patients like complete haemogram, which includes Hb, total and differential count, erythrocytesedimentation rate, serum creatinine level.

Radiological investigations: It includes Magnetic resonance imaging (MRI) and Computed tomography Urography

MRI system consists of the following sequences.(Magnetic resonance imaging Machine: 1.5 T MagnetomEssenza Siemens, 16channels.)

1. **Coronal T2-weighted half Fourier single-shot turbo spin echo sequence (HASTE) (TR infinite, TE 120 ms, flip angle 90°, breath-hold),** serving as a localizer, but also supplying valuable T2-weighted information. The limitation of this sequence is arelatively low signal-to-noise ratio**.**
2. **Axial T2-weighted turbo spin echo sequence with fat suppression (TR 2,000 ms, TE 100 ms, flip angle 90°, respiratory triggering).** This sequence provides for more detailed T2-weighted information. The T2-weighted sequence is especially helpful in characterizing cysts and

intraparenchymal abscesses and in evaluating hydronephrosis. Furthermore, the T2-weighted sequence is helpful in detecting solid lesions.

3. **Axial T1-weighted gradient echo sequence, in-phase and opposed-phase (TR 180 ms, TE 2.3 ms/4.6 ms, flip angle 90°, breath-hold), preferably asdual-echo sequence**. Many solid renal lesions are hypointense compared to the renal parenchyma on T1-weighted images, but lesions with haemorrhage, lesions with macroscopic fat, melanin-containing lesions and cysts with high protein content may show hyperintense signal. Opposed-phase T1weighted gradient echo sequences can be used to prove the presence of small amounts of fat.

Computed tomography Urography: (Machine: 16-slice Computed tomography scanner)

In multi–detector row Computed tomography urographic procedure with imagesobtained during unenhanced, nephrographic, early excretory, and delayed excretory phases. The unenhanced images are obtained through the abdomen and pelvis at 4 × 3.75-mm collimation each (four detector rows at 3.75-mm collimation) and are reconstructed at a 5-mm section thickness. Nephrographic phase images are obtained 100 seconds after the initiation of an intravenous injection of low-osmolality nonioniccontrast material (150 mL of Omnipaque300 at 3 mL/sec). Nephrographic phase images are obtained from the diaphragm through the kidneys by using 4 × 2.5-mm collimation and reconstructed at 5-mm section thickness. Early and late excretory phase images were obtained at 300- and 450-second delays, respectively, with the following technique: 4 × 1.25-mm collimation, reconstructed section thickness of 2.5 mm, and 50% (1.25-mm) overlapping intervals. Allimaging examinations are performed at 120 kVp and 120–280 mA. Three-dimensional reconstructions of the twoexcretory phase scans are created at an independent workstation.

Inclusion Criteria:

a) Any patients with clinical symptoms of urinary tract disease (obstructive and Non-obstructive disease).
b) Previous history of contrast allergy.
c) Renal failure
d) Poorly functioning kidneys where contrast is contraindicated.

Exclusion Criteria:

a) Cardiac Pacemaker
b) Metallic implants
c) Claustrophobia
d) Non co-operative patient
e) Excessive fluid in bowel loops
f) Pregnant or lactating women

Ethical clearance: Ethical clearance has been taken from the ethical committee of the institute.

RESULTS

Table - 1 shows cases of congenital lesions. Congenital lesions are found in 25.00% of the patients, equally in both CT and non contrast MR urography. Out of which more common lesion is urachal remnant found in 6.25% patients in both CT and non contrast MR urography.

Table 1: Cases of congenital lesions

Congenital lesion	CT Urography (%, n=32)	Non-contrast MR Urography (%, n=32)
Present	8 (25.00%)	8 (25.00%)
Urachal remnant	2 (6.25%)	2 (6.25%)
Horse –shoe Kidneys	1 (3.12%)	1 (3.12%)
Right ectopic kidney	1 (3.12%)	1 (3.12%)
Bilateral duplex collecting system	1 (3.12%)	1 (3.12%)
Double ureter on left side	1 (3.12%)	1 (3.12%)
Median umbilical ligament	1 (3.12%)	1 (3.12%)
Polycystic kidney disease	1 (3.12%)	1 (3.12%)

Table 2 shows cases of obstruction by stones. Around 46.87% patients with urinary stones are diagnosed in CT urography and 43.75% patients with urinary stones are diagnosed in non contrast MR urography. Out of which 34.37% patients are having renal stones in CT urography and 28.12% patients having renal stones in non contrast MR urography. 12.50% patients are having ureteric stones in CT urography and 15.62% patients having ureteric stones in non contrast MR urography. Two tiny renal stones were not found in non contrast MR urography and one tiny ureteric stone was not found in CT urography.

Table 2: Cases of obstruction by stones

Variable		CT Urography No. Of lesions (%, n=32)	Non-contrast MRI Urography No. Of lesions (%, n=32)
Stone	Present	15 (46.87%)	14(43.75%)
Location	Kidneys	11 (34.37%)	9 (28.12%)
	Ureter	4 (12.50%)	5 (15.62%)

Table-3 shows cases of urinary tract infection. Infective lesions are found in 31.25% of the patients, equally in both CT and non contrast MR urography. Out of which more common lesion is pyelonephritis found in 9.37 % of patients in CT urography and 15.62 % of patients in non contrast MR urography.

Table 3: Cases of infections

Type of infections	CT Urography No. Of lesions (%, n=32)	Non-contrast MR Urography No. Of lesions (%, n=32)
Present	10 (31.25%)	10 (31.25%)
Pyelonephritis	3 (9.37%)	5 (15.62%)
Pyonephrosis	1 (3.12%)	1 (3.12%)
Pyelitis	1 (3.12%)	0 (0%)
Xantho-granulomatous pyelonephritis	1 (3.12%)	1 (3.12%)
Ureteritis	1 (3.12%)	1 (3.12%)
Infected urachal remnant	2 (6.25%)	1 (3.12%)
Tuberculosis	1 (3.12%)	1 (3.12%)

Table-4 shows cases of cysts. Cysts are found in 6.25% of the patients in CT and 18.75% of the patients in non contrast MR urography

As shown in **figure 1 and 2**, the cases of supernumerary kidney in horse shoe configuration with both kidneys and xanthogranulomatous pyelonephritis can be nicely demonstrated respectively in both CT urography and non contrast MR urography.

Table 4: Cases of cysts

Cysts	CT Urography No. Of lesions (%, n=32)	Non-contrast MR Urography No. Of lesions (%, n=32)
Present	2 (6.25%)	6 (18.75%)
Absent	30 (93.75%)	26 (81.25%)

DISCUSSION

In the present study 32 patients were included, who underwent CT urography and non-contrast MR urography. Available pathological and surgical findings were corroborated with the imaging findings.

There were 8 (25%) cases of congenital anomalies: 2 (6.25%) cases of urachal remnant, 1 case of bilateral duplex collecting system, 1 (3.12%) cases of left sided double ureter, 1 (3.12%) case supernumerary kidney in horse-shoe configuration, 1 (3.12%) ectopic kidney, 1 (3.12%) median umbilical ligament and 1 (3.12%) autosomal dominant polycystic kidney disease.

In a retrospective cohort study done by Glodny et al in 209 patients concluded CT urography as the most reliable imaging method in cases of horseshoe kidneys & crossed fused ectopia [5]. Various studies done by McCollough et al [6], Nolte – Ernsting CC et al [7] & Herts BR et al[8] have shown CT urography has detected a variety of congenital anomalies of the urinary tract, including partial duplications, complete duplications, ectopic ureteroceles, pelvic kidneys and horseshoe kidneys.

In our study, obstructive uropathy was caused by calculus disease. Total 15 (46.87%) patients were detected to have stone as a cause of obstructive uropathy on CT urography out of which only 14 (43.75%) patients were detected to have stone as a cause of obstructive uropathy on non contrast MR urography. These findings are compatible with study done by Col K K Sen et al which show detection of lesser number of stones in MR urography as compared with CT urography [9].

In our study, 2 (6.25%) patients are detected having cysts in urinary system on CT urography and 6 (18.75%) patients having cysts in urinary system on non contrast MR urography. These findings are compatible with study done by Israel GM, et al. which shows 56 (81.16%) patients having cyst in urinary tract on CT urography and 69 (100%) patients having cysts in urinary tract on non contrast MR urography [10]. Thus non contrast MR urography is better in detection of cystic lesion as compared with CT urography.

In our study, we found equal numbers of patients (31.25%) having urinary tract infective lesion in CT urography as well as in non contrast MR urography.

These findings are compatible with study done by William D Craig et al [11], all infective lesion of urinary tract were detected by both CT urography and contrast MR urography in equal numbers.

Figure 1: Supernumerary kidney in horse shoe configuration with both kidneys: A and B (CT), C and D (MRI): Left kidney with right unascended kidney (arrow) supernumerary kidney in horse shoe configuration with both kidneys.

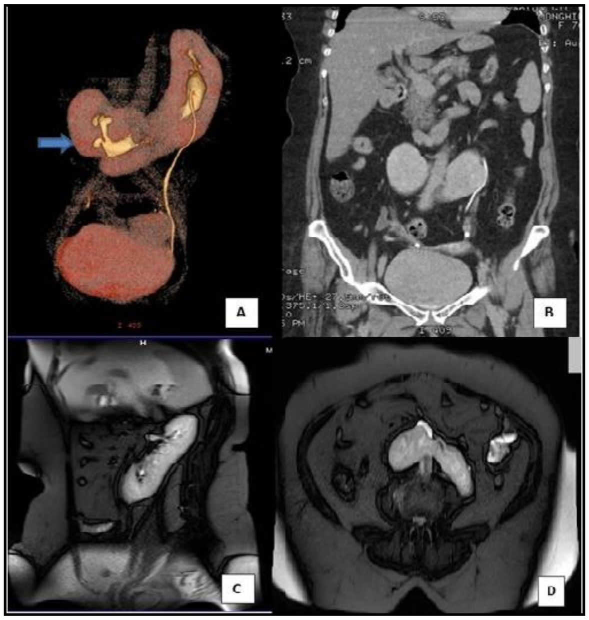
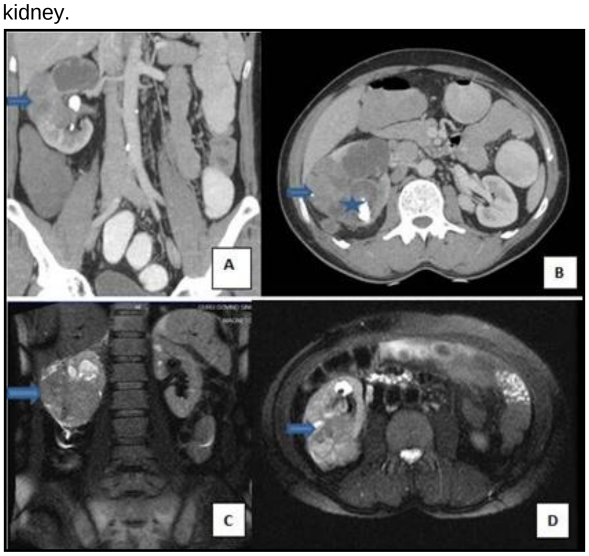


Figure 2: Xanthogranulomatous pyelonephritis: A and B (Contrast enhanced CT) -Exophytic enhancing lesion (arrow) involving posterior aspect mid part of right kidney. Multiple right renal stones (star) with focal hydro-calycosis of upper calyx. **C and D (T2W coronal and axial)**– A hypointense lesion involving posterior aspect mid part of kidney.



CONCLUSION

CT urography represents the most comprehensive imaging examination of the urinary tract than non contrast MR urography for detection of stones and causes of obstructive uropathy. While non contrast MR urography is more useful in detecting cystic lesions of urinary tract.

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Corresponding Author:

Dr M.T.Makda
Department of Radiodiagnosis,
Shri M.P. Shah Govt Medical College & GGH
Jamnagar-361001, Gujarat, India.
Email: drmakada_2006@yahoo.co.in

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