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A comparative study of plain Radiography, Ultrasound and static MR Urography in evaluation of Urinary Tract Pathologies

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Abstract

Background: *Several techniques are available for the imaging of the urinary tract. CT urography and MR urography are used for of urinary collecting system, renal parenchyma, and adjacent structures. Recently, interest has grown for increased use of MR urography for imaging the urinary tract pathologies. The present study aimed to evaluate patients presenting with suspected urinary tract abnormalities using plain radiography, ultrasonography, and static MR urography.* ***Methods:*** *This is a prospective comparative study was done in the Department of Radio-Diagnosis, Prathima Institute of medical sciences Karimnagar, Telangana State, India. Data for the study were collected from patients with clinically suspected urinary tract pathologies undergoing plain X-ray KUB, ultrasonography and static MR urography in our Department. A total of n=60 patients were included based on the inclusion and exclusion criteria. Patients were selected based on their symptoms and clinical findings suggestive of urinary tract abnormalities such as loin pain, hematuria, edema, and congenital urinary tract anomalies.* ***Results:*** *The most common presentation was presence of loin pain in n=32(47.70%) followed by nausea and vomiting in n=10(14.90%) patients. The urinary tract abnormalities among the population shows the presence of obstructive calculi in n=30(50%) of patients followed by congenital abnormalities in n=18(%). In our study, most common site of obstruction of calculi was found to be PUJ followed by lower ureter. The presence of hydernephrosis was found in n=30 patients, out of the n=30 patients mild hydronephrosis was found in n=10(33.3%) of patients. Moderate hydronpehrosis was found in n=15(50%) of patients and severe hydronephrosis was found in n=5(16.7%) of patients.* ***Conclusion:*** *The role of MR Urography in renal and urothelial imaging continues to emerge. MRU is a particularly useful technique for pregnant females, pediatric patients, cardiac patients and those with renal impairment. MRU is preferable to X-ray and ultrasound in the assessment of collecting systems in case of obstruction, diagnosis, and staging of urothelial malignancies and assessment of renal function.*

Keywords*: Plain Radiography, Ultrasound and Static MR Urography*

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Introduction

A variety of techniques have been developed for imaging the urinary tract that includes plain X-rays KUB, IVU, RGU, cystography, ultrasound, CT and MRI. MR urography is an evolving group of techniques with the potential to noninvasively provide the most comprehensive and specific imaging test available for many urinary tract abnormalities without the use of ionizing radiation [1, 2]. At the same time, formidable limitations and challenges remain for MR urography, including its relative insensitivity for renal calculi, relatively long imaging times, sensitivity to motion, and lower spatial resolution compared with CT and radiography [3]. For many years excretory urography was the investigation of choice for imaging patients with urinary tract obstruction. Functional and anatomic details are provided by this imaging technique [4]. The use of ionizing

radiation, contrast material, inability to visualize radiolucent stones and the possible obscuring of small stones by bowel and bony structures are the major drawbacks of excretory urography. Also, it is contraindicated in pregnant patients, patients with severe renal failure, cardiac disease and those with contrast allergy. Given the relatively low cost and quick performance times, ultrasonography has become one of the most important tools for assessing the urinary tract. It does not require intravenous contrast and does not use ionizing radiation [5]. Besides, there are no known side effects caused by this test. However, ureters are often difficult to be determined by USG because of overlying bowel gas and dilatation may not be seen early in acute cases. Computed tomography (CT) has challenged excretory urography in the evaluation of the genitourinary system. It is more sensitive and specific in the detection and characterization of urinary tract abnormalities. Studies have shown helical CT to be superior to radiography and excretory urography for the detection of renal and ureteral calculi [6]. However, a radiation dose may preclude the use of this technique in pregnant. MR urography has become an integral part of the recently emerging advances that involve clinical uroradiology. It is a new non-invasive tool of good diagnostic value that can be used to image all kinds of urinary tract disorders in adults, pregnant and pediatric patients. It does not require ionizing radiation or iodinated contrast material and provide an alternative to invasive urinary tract imaging techniques. The RARE (rapid acquisition with relaxation enhancement) sequence technique was the first approach to visualize the urinary tract using MR imaging [7]. Then, a heavily T2-weighted fast spin-echo sequence originated from the development of the RARE technique. HASTE technique (half-Fourier acquisition single-shot turbo spin-echo) uses modified rapid acquisition with relaxation enhancement to obtain heavily T2-weighted images in a short time making it suitable for patients unable to cooperate, especially in children, older patients, and patients in deteriorated condition. T1-weighted gadolinium-enhanced MRU technique provides an excellent depiction of the non-dilated urinary tract which is invisible or incompletely visualized by static T2- weighted MRU [8, 9]. The successful interpretation of MR urographic examinations requires familiarity with the many pitfalls and artifacts that can be encountered with these techniques. With this background, we in the present study tried to evaluate patients presenting with suspected urinary tract abnormalities using plain radiography, ultrasonography, and static MR urography.

Materials and Methods

This is a prospective comparative study done in the Department of Radio-Diagnosis, Prathima Institute of Medical Sciences, Naganoor, Karimnagar, Telangana State, India. The Institutional Ethics committee accepted the study protocol. Data for the study were collected from patients with clinically suspected urinary tract pathologies undergoing plain X-ray KUB, ultrasonography and static MR urography in our Department.

Inclusion criteria were all patients presenting with clinical signs and symptoms suggestive of urinary tract problems.

Exclusion criteria

1. Patients in whom MR was contraindicated due to any reason.
2. Patients with prior urinary tract surgery.
3. Patients with a history of abdominal trauma.

A total of n=60 patients were included based on the inclusion and exclusion criteria. Patients were selected based on their symptoms and clinical findings suggestive of urinary tract abnormalities such as loin pain, hematuria, edema, and congenital urinary tract anomalies. After a thorough history and complete clinical examination these patients were subjected to plain radiography KUB (CARESTREAM DRX-1 system), ultrasonography (PHILIPS HD30 machine) and MR urography (1.5T PHILIPS ACHIEVA MRI SCANNER) the procedures and techniques adapted were as per standard protocol. The data was recorded on the MS Excel spreadsheet and analyzed by SPSS version 17 on Windows format.

Results

A total of n=60 patients were found during the study period out of which the most common age group involved was 42- 50 years with n=14(23.3%) and 31 – 40 years with n=13(21.7%) of patients. The other age-wise

distribution is shown in table 1. In the present study out of n=60 patients, n=33(55%) were male and n=27 (45%) were females. Obstructive calculi were found in a total of n=30 patients on the right side in n=17 patients and the left side in n=11 and bilateral calculi were found in n=2 patients.

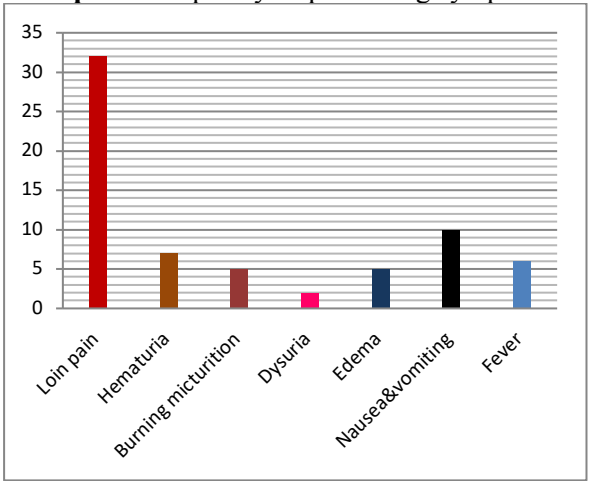
Table 1: Age-wise distribution

Age (Years)	Number	Percentage
0-10	1	1.7
11-20	5	8.3
21-30	11	18.3
31-40	13	21.7
41-50	14	23.3
51-60	11	18.3
61-70	2	3.3
71-80	2	3.3
> 80	1	1.7
Total	60	100

Table 2: Gender wise distribution

Gender	Number	Percentage
Female	33	55
Male	27	45
Total	60	100

Graph 1: Frequency of presenting symptoms



The most common presentation was the presence of loin pain in n=32(47.70%) followed by nausea and vomiting in n=10(14.90%) patients. The urinary tract abnormalities among the population show the presence of obstructive calculi in n=30(50%) of patients followed by congenital abnormalities in n=18(%) other details are shown in table 3.

In our study, the most common site of obstruction of calculi was found to be PUJ followed by lower ureter. The presence of hydronephrosis was found in n=30 patients, Outof the n=30 patients, mild hydronephrosis was found in n=10(33.3%) of patients. Moderate hydronephrosis was found in n=15(50%) of patients and severe hydronephrosis was found in n=5(16.7%) of patients.

Table 3: Distribution of urinary tract abnormalities

Disease	Number	Percentage
Obstructive calculi	30	50
Congenital anomalies	11	18
Tumors	6	10
PUJ narrowing	4	7
Ca Cx with B/L Hydronephrosis	4	7
B/L PCKD	3	5
Pyelonephritis	2	3
Total	60	100

Table 4: Distribution of calculi in the collecting system

Site of Obstruction	Number	Percentage
PUJ	12	40.0
Upper ureter	2	6.7
Mid ureter	5	16.7
Lower ureter	7	23.3
VUJ	4	13.3
Total	30	100

Out of n=6 neoplasms in this study, we found the most common neoplasm to be bladder Transitional cell carcinoma in n=3 patients. Among the congenital abnormalities in n=8 patients crossed fused kidneys were found in n=2(25%) and ectopic kidneys were found in n=2(25%) and one case each of agenesis, bifid kidney, malrotation kidney, and horseshoe kidneys. The abnormalities of ureter showed one case each of the congenital megaureter, Duplex collecting system, and retrocaval ureter.

Table 5: Distribution of urinary tract neoplasms

Tumor	Number	Percentage
Bladder TCC	3	50
Renal Angiomyolipoma	2	33
RCC	1	17
Total	6	100

Discussion

The present study included a total of n=60 patients of both genders (n=27 male and n=33 female). The highest numbers of patients were in the age group of 41-50 years with a slight female preponderance and female to male ratio of 1.2:1. Among n=60 patients studied,

Obstructive calculi are the most common urinary tract pathologies, seen in n=30 patients accounting for 50% of the cases. After calculi, congenital anomalies were the second most common problem. Males of 31-40 years age group were the most commonly affected followed by females of 21-30 years which is in accordance to study by Suzan et al;[10]Plain x-ray KUB and ultrasound have been the initial modality of choice in imaging the patients with renal colic. The sensitivity and specificity of plain X-ray in ureteral lithiasis were 83.3% and 93.3% respectively in the present study. Syed et al; [11] compared the diagnostic accuracy of X-ray KUB and ultrasound in ureteric colic. The specificity of CT was 100%, the US was 76% whereas, X-ray KUB was 94%, sensitivity for CT 100%, US 52.6% and X-ray KUB 89.5% respectively. Ultrasound is considered safe, fast and is the initial modality of choice in patients coming with acute renal colic even in non-ambulatory patients and those with renal impairment. In the present study, the symptom of pain was the most common symptom of 47.7 % of patients. Although some renal stones remain asymptomatic, most will result in pain. Small stones that arise in the kidney are more likely to pass into the ureters where they may result in colic. These results were consistent with Suzan et al; [10] and Tamm et al; [12] the sensitivity and specificity of ureteric calculi detection on the US were 12% and 97% respectively. The sensitivity and specificity of urinary bladder calculi detection in the US were 20% and 100% respectively. This study showed that the accuracy of the US in detecting renal, ureteric and urinary bladder calculi was 67%, 80%, and 98% respectively. The wide range of variability in sensitivity and specificity for ultrasound is due to its operator dependence, calculus size, location and degree of obstruction.MR urography is the imaging of choice in obstructed ureters where CT is contraindicated and where the radiation dose is of concern. The present study showed that static MR urography can detect the ureteral stones in dilated ureters with a sensitivity and specificity of 92% and 99% respectively. The sensitivity of MRU in the detection of obstructing renal calculi has been reported to be as high as 94–100% 26. However, MRU is less sensitive for the detection of calculi in the absence of urinary obstruction. Static-fluid MR urography can be performed with a variety of T2-weighted techniques, including half-Fourier single-shot echo-train spin-echo sequences (such as HASTE), thick-slab RARE or respiratory-triggered three-dimensional echo-train spin-echo sequences. Renal calculi, urothelial tumors, and blood clots may appear as filling defects on both static-fluid and excretory MRU images. A study by N. Balci et al; [13] concluded that neither the RARE nor the HASTE sequences allowed the evaluation of the entire urinary tract under non-obstructive conditions. Although it cannot entirely replace intravenous urography, MR urography seems to lend itself to combination with other MR techniques, particularly in the investigation of pelvic or retroperitoneal disease. Tang Y et al; [14] compared the accuracy of HASTE MR urography with excretory urography in revealing the urinary tract dilatation and level of obstruction. The neoplasms were 3rd most common urinary tract pathologies in the present study accounting for 10% of cases and included TCC of the bladder, RCC and Renal angiomyolipomas. Bladder TCC was the commonest neoplasm constituting 50% of the neoplasms. Ultrasound detected all the tumors but MR urography helped in extension and staging of the tumors. S. Kern et al; [15] compared 0.23-T and 1.5-T MR systems using T1-weighted (T1-W) spin-echo, T2-weighted (T2-W) turbo-spin-echo and RARE-MR-urography sequences in ARPKD. Signal intensities, morphological appearance of the affected kidneys and, specifically, the picture of the urinary tract on RARE-MR-urography were evaluated. All children showed kidney enlargement, reniform but humpy kidney shape, homogeneously grainy renal parenchyma, normal renal pelvis, and normal calyces. Signal intensity was hyperintense in T2-W images in all cases. On RARE-MR urography a hyperintense, linear radial pattern was seen in the cortex and medulla which represents the characteristic microcystic dilatation of collecting ducts in ARPKD. Congenital anomalies are the second most common urinary tract abnormalities in the present study comprising 11 of 60 patients accounting for 18% of cases. Early diagnosis and adequate treatment and management of congenital urinary tract malformations and its complications have

improved prognosis and long-term outcomes. The most common congenital variants in the present study were ectopic kidneys and crossed fused renal ectopia accounting for 4 of 11 cases (36%). In the present study X-ray, KUB did not play a significant role in the diagnosis of anatomic variants. All the 11 patients were initially scanned by ultrasound and the diagnosis was correctly made in 7 cases. But the course of the ureters was not visualized by the US. These patients then underwent a Static MR urogram using T2 weighted Turbo-spin-echo sequences and the diagnosis was confirmed. One case of ectopic kidney diagnosed as agenesis by ultrasound showed ectopic kidney in the pelvis by MR Urogram another case diagnosed as left moderate to severe hydroureteronephrosis by ultrasound showed congenital megaureter by MR Urogram.

Conclusion

The role of MR Urography in renal and urothelial imaging continues to emerge. MRU is a particularly useful technique for pregnant females, pediatric patients, cardiac patients and those with renal impairment. MRU is preferable to X-ray and ultrasound in the assessment of collecting systems in case of obstruction, diagnosis and staging of urothelial malignancies and assessment of renal function. MRU can also give additional information in patients with obstructive calculi compared to X-ray and US such as perirenal and periureteric fluid collections, exact location and severity of obstruction and can guide in surgical approach and treatment plan.

Conflict of Interest: *None declared*
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