Section: Radiodiagnosis

Original Research Article

UTILITY OF MR UROGRAPHY VERSUS CT IN OBSTRUCTIVE UROPATHY IN A TERTIARY CARE CENTRE – A PROSPECTIVE STUDY

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Abstract

Background: Obstructive uropathy is a common public health problem requiring imaging studies to provide needed information. Multiple diagnostic instruments must be evaluated to determine a primary diagnosis technique with high accuracy. The study aims to explore and identify the possibilities of non-contrast MR Urography as a primary investigation and its advantages over CT in assessing Obstructive Uropathy. **Materials and Methods:** This prospective observational study occurred at our Department of Radiodiagnosis between November 2018 and April 2018. The study focused on subjects displaying hydronephrosis on ultrasound (USG) or intravenous urography (IVU). A convenient sample of subjects participated, and demographic and clinical data were collected from medical records and a medical history questionnaire, respectively. Imaging data from CT KUB and MR urography images were gathered, tabulated, compiled, and subjected to statistical analysis. **Result:** The study was conducted among 29 patients undergoing USG or IVU with hydronephrosis. A male predominance was reported in the study (55.2%). MRU and CTU findings revealed calculus in 13.8% of patients, obstructive calculus (10.3%) and obstructive calculus with cyst (13.8%). PUJ obstruction due to stricture was seen in 3.4%. **Conclusion:** MRU has been proven to be more sensitive in evaluating the anatomical characteristics of the kidneys and renal calculi in most patients. Both CTU and MRU are reliable procedures, with CTU effectively diagnosing obstructive uropathy and MRU providing a more technical clinical examination.

INTRODUCTION

Obstructive uropathy is characterized by the blockage of the urine drainage system at any position within the urinary tract from the kidneys, bilateral ureters till the urinary bladder.[1] Hydronephrosis refers to the dilatation of the renal calyces and pelvis due to the backflow pressure exerted by the urine proximal to the site of obstruction. [2,3]

Obstructive uropathy has the potential to be both a chronic disorder that affects the individual over time or an acute state causing symptoms immediately, either-ways necessitating repeated investigations. Furthermore, the obstruction can be unilateral or bilateral.[3]

Symptoms of obstructive uropathy have been found to include nausea, vomiting, and profuse sweating or diaphoresis, as well as discomfort in the abdomen and loin pain.[4] Clinicians have discovered numerous underlying causes of obstructive uropathy, the most common of which are renal or ureteric stones.[5] Aside from renal calculus, the reasons for obstruction may also include pregnancy, prostate cancer, retroperitoneal fibrosis,[6,7] spinal cord injury,[8,9] ureteral stricture, and congenital malformations, such as pelvic-ureteric junction obstruction. The growth of smooth muscle cells lining the pelvis and ureter is more vulnerable to injury when the kidneys are obstructed. The primary source of urinary tract physiological blockage is damage to the renal pelvis and impairment in smooth muscle differentiation.[10]

Magnetic resonance urography (MRU) is a high specificity-sensitive method for identifying non-calculus obstructive uropathy caused by lesions such as pelvic-ureteric junction [PUJ] obstruction. MRI can offer functional and anatomical information on probable kidney obstructions without injecting nephrotoxic contrast or ionizing radiation.[11] MRU has been shown to have the best accuracy in detecting hydroureteronephrosis.[12] Compared to the other modalities, it has reduced sensitivity in detecting urinary calculi. Still, it is a superior modality for evaluating malignant and benign obstruction causes due to its multiplanar capacity and greater soft tissue contrast. CT (Computerized Tomography) Urography (CTU) is a modality with high sensitivity and specificity in diagnosing renal calculi. [13,14] CTU can diagnose renal stones and even determine their composition. Intravenous urography is a technique with decreased radiation exposure but is ineffective in detecting renal stones that may cause obstructive uropathy.[15] After the emergence of rival imaging technologies and concerns about the harmful effects of radiation and contrast media, even intravenous urography with relatively low radiation exposure than CTU has fallen out of favor. As a result, the MRU approach is required to assess the sources and degree of blockage.

As stated, Non-Contrast-Enhanced Computed Tomography (NCCT) is the most effective imaging modality for detecting and monitoring urolithiasis.[16] Once again, its biggest drawback is its radiation dosage to patients.[17] According to Ferrandino et al., around 20% of patients got considerable radiation doses during short-term follow-ups of an acute stone.[18] Other rare causes of urolithiasis, such as cancers, can be diagnosed with CECT.[19] Because of the high radiation dose of CT, many investigators prefer MRI; nonetheless, CT offers higher accuracy in diagnosing urinary tract obstruction.[20]

The current study aims to identify the possibilities of using non-contrast MR urography for obstructive uropathy as a primary diagnosis compared to CTU.

MATERIALS AND METHODS

The prospective observational study was conducted for six months (December 2018 to May 2019) in the radiology department based in a tertiary care hospital. The study was conducted after approval by the hospital's ethics committee, and proper patient consent was obtained from the patients. Patients with hydronephrosis in USG or intravenous urography (IVU) were enrolled in the study.

Inclusion Criteria

- Patients with hydronephrosis on USG or IVU

Exclusion Criteria

- Patients undergoing CT-KUB in the radiology department
- Pregnant women
- Patients who did not provide consent

Patients were enrolled with the inclusion and exclusion criteria from December 2018.

Data Collection: Patients' details were collected, including demographics, CT, and MRI findings.

Data Analysis: For compilation, patient data were included in MS Excel, and SPSS software 21.0 was used for statistical analysis.

RESULTS

Twenty-nine patients with hydronephrosis or hydroureteronephrosis undergoing USG or IVU were enrolled in the study.

The data shows that 50% of the patients in the study were female (13 out of 26), and 50% were male (13 out of 26). This suggests no gender predominance in the incidence of USG calculus cases. The incidence of USG calculus cases is highest in the 41-50-year-old age group, with seven patients (26.9%), followed by the > 61-year-old age group (15.4%). The incidence is lowest in the <20-year-old age group. [Table 1]

Table 1: Demographic details of the patients

		Count	Column N %
Sex	F	13	50%
	M	13	50%
Age group	<20	4	15.4%
	21-30	3	11.5%
	31-40	3	11.5%
	41-50	7	26.9%
	51-60	5	19.2%
	>61	4	15.4%

Table 2: Radiological findings

	Frequency	Percentage
Calculus	4	15.4%
Obstructive Calculus at VUJ	3	11.5%
Cyst	7	26.9%
Infiltrating lesion	1	3.8%
Calculus & Cyst & Ureteral wall thickening	3	11.5%
Calculus & Ureteral wall thickening	1	3.8%
Obstructive Calculus & Cyst	1	3.8%
Obstructive Calculus & Ureteral wall thickening	4	15.4%
PUJ Obstruction & Infiltrating lesion & Stricture	1	3.8%
PUJ Obstruction & stricture	1	3.8%

Table 3: Radiological findings

CT scan		Non contrast MR Urography		Total
		Present	Absent	
Obstructive Calculus < 3mm	Present	2	1	3

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	Absent	0	0	0
Obstructive Calculus 3 - 3.5 mm	Present	4	0	4
	Absent	0	0	0
Obstructive Calculus > 3.5 mm	Present	4	0	4
	Absent	0	0	0
Non-obstructive Calculus < 3mm	Present	0	10	10
	Absent	0	1	1
Non-obstructive Calculus 3 - 3.5 mm	Present	0	1	1
	Absent	0	0	0
Non-obstructive Calculus > 3.5 mm	Present	5	0	5
	Absent	0	0	0

Table 4: Radiological findings

CT scan		**Non-contrast MR Urography**		**Total**
		Present	**Absent**	
PUJ Obstruction	Present	4	0	4
	Absent	0	0	0
Cyst	Present	12	0	12
	Absent	0	0	0
Infiltrating lesion	Present	1	0	1
	Absent	1	0	1
Ureteral wall thickening	Present	3	0	3
	Absent	0	0	0
Stricture	Present	3	0	3
	Absent	1	0	1

Calculi, or stones within the urinary system as a sole finding were present in 4 patients (15.4%), a common cause of this condition. Specifically, three patients (11.5%) had obstructive calculi, indicating a stone causing blockage or obstruction in the vescico-ureteric junction. Cysts were found in 7 patients (26.9%), not contributing to obstructive uropathy. An infiltrating lesion, suggestive of an abnormal growth spreading and invading urothelial tissues, was observed in 1 patient (3.8%). Additionally, coexisting conditions were identified, such as a combination of calculus, cyst, and ureteral wall thickening in 1 patient (3.8%) and a combination of calculus and ureteral wall thickening in another patient (3.4%), both contributing to obstructive uropathy. Furthermore, four patients (15.4%) had obstructive calculi and cysts, while one (3.8%) had obstructive calculus and ureteral wall thickening, highlighting their role in this condition. Among the patients, 1 (3.8%) exhibited Pelvi-Ureteric Junction (PUJ) obstruction due to infiltrating lesion and stricture simultaneously, suggesting their combined contribution to obstructive uropathy. Finally, three patients (11.5%) had PUJ obstruction due to stricture alone contributing to this condition. [Table 2]

The CT scan and non-contrast MR Urography imaging techniques in evaluating calculi demonstrated consistent and reliable results. Two patients with calculi smaller than 3mm were identified, while only one did not have such calculi, indicating agreement between the methods. In the 3mm to 3.5mm size range, all four patients showed positive results on both imaging techniques, with none lacking obstructive calculi in this range. Similarly, for calculi larger than 3.5mm, all four patients had confirmatory results, and no cases showed the absence of larger obstructive calculi, highlighting the methods' reliability. CT scan and non-contrast MR Urography consistently detected non-obstructive calculi smaller than 3mm in 10 patients. Additionally, no patients were identified with non-obstructive calculi in the 3mm to 3.5mm size range, confirming the agreement between the techniques. Finally, five patients had non-obstructive calculi larger than 3.5mm on both imaging methods, with no patients lacking larger non-obstructive calculi, demonstrating the effectiveness of CT scan and non-contrast MR Urography in detecting larger non-obstructive calculi. [Table 3]

In the study, PUJ obstruction was identified in 4 patients, with no cases showing the absence of this condition based on either imaging technique. Cysts were present in 12 patients, and no cases showed the absence of cysts according to either imaging technique. One patient had an infiltrating lesion, while another patient did not have an infiltrating lesion according to both CT scan and non-contrast MR Urography. Ureteral wall thickening was observed in 3 patients, and no patients showed the absence of this condition according to either imaging technique. Finally, strictures were found in 3 patients; one did not have a stricture according to both imaging techniques. These findings highlight the utility and agreement between CT scans and non-contrast MR Urography in identifying and evaluating various urologic conditions. [Table 4]

MRU diagnoses all obstructive calculus more than 3 mm. Only those less than 3.5 mm have difficulty diagnosing by MRU. Hence, all symptomatic patients are most likely to get a diagnosis by MRU. Moreover, MRI has better sensitivity for other lesions like infiltrating and strictures.

DISCUSSION

Magnetic Resonance Urography (MRU), Computed Tomographic Urography (CTU) and Intra Venous Urography (IVU) are becoming more popular for diagnosing urinary tract problems in cases of obstructive uropathy. In this study, we compare MRU with CTU. Each imaging approach has advantages and weaknesses, but each gives a great definition of imaging for normal and pathological circumstances.[21] The current study revealed that cyst was the most common finding in 7 patients (26.9%), and conditions such as cyst with calculus were far more prevalent. In addition, obstructive renal calculi were seen in the majority of the patients. Obstructive calculus between 3-3.5 mm was prevalent in 4 patients, followed by size >3.5 mm, reported in 4 patients respectively noted in both CT and MR Urography. Non-obstructive calculi with a size >3.5 mm were prevalent in 5 patients with both imaging methods, with no patients missing out in MRU for larger (>3.5 mm) non-obstructive calculi, confirming the equal efficiency of CT scan and non-contrast MR Urography in identifying non-obstructive calculi more than 3.5 mm in its largest dimension. The findings are consistent with previous research and reveal that CTU is more sensitive in identifying stones; However, our study indicates that MRU is equally sensitive for calculi for than 3.5 mm in its largest dimension, whether or not there is an obstructive phenomenon.

Our study was done with Philips Intera 1.5 Tesla MRI scanner. The study took this strategy because the 1Tesla MRI scanner was sufficient to identify even a small renal calculus. It is the single modality identifying a cause for obstruction (especially TCC) where patients are jeopardized due to renal dysfunction.[22] Furthermore, Jung et al. reported that MRU correctly diagnosed 88.9% of patients with ureteric stones, whereas traditional intravenous urography correctly diagnosed 68.1% of patients only.[23] In addition, Ather et al. examined the sensitivity and specificity of US and NCCT in patients with renal failure. They discovered that they were 81% and 100%, respectively, for renal stones and 93% and 100%, respectively, for hydronephrosis.[24] Kaya et al. conducted research to compare intravenous urography (IVU) and computed tomography urography (CTU) in diagnosing ureteropelvic junction obstruction (UJO) and discovered that CTU had a diagnostic accuracy of 85.2% and IVU had a diagnostic accuracy of 49.2%. Furthermore, the study revealed that CTU had stronger diagnostic effectiveness than IVU.[25] Finally, Khan et al. demonstrated that CTU had a greater detection rate for ureterolithiasis than IVU, particularly for calculus in the distal ureter.[26] Shokier et al. also observed that MRU is more sensitive and specific for non-calculous urinary tract obstruction than CTU.

Tumors with various biological characteristics and activities may be easily seen and diagnosed using MRI urography, esp Transitional cell carcinoma. MRU inherently has greater contrast for soft tissues, avoids ionizing radiation, and precludes using an iodinated contrast medium, making it a more effective modality than CTU. Furthermore, the procedure includes other possibilities that may be explored through a complete review of the renal vasculature, microstructures, and system oxygenation.

CTU is the most sensitive modality for identifying renal calculus. However, its repetitive usage for frequent follow-up of patients with obstructive cannot be justified because of the high radiation dosage it imparts, even though it is cost-effective. This compels us to a non-radiation alternative modality that can detect the cause of obstructive uropathy.

Even though MRU has lower sensitivity than CTU for non-obstructive uropathy, its sensitivity and specificity are comparable with CTU in Obstructive uropathy, especially for calculus >3.5mm in its largest dimension. The only disadvantage being its high cost. In our study, 90% of obstructive calculus, including that < 3.5 mm, was identified, and 100% of obstructive calculus >3.5 mm was identified. Thereby it is seen that MRU significantly decreases the patient radiation dose if used as an alternative.

CONCLUSION

MRU provides high-resolution imaging without radiation and effectively diagnoses obstructive calculus larger than 3 mm, while smaller ones pose challenges. Symptomatic patients are more likely to receive a diagnosis through MRU, which also excels in detecting infiltrating lesions, and strictures.

We suggest MRU as an effective alternative to CTU in diagnosing the cause of obstructive uropathy whenever feasible.

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