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Original Research Article

MR urography in evaluating obstructive uropathy: one stop shop

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ABSTRACT

Background: Any anatomical or physiological obstruction to flow of urine in urinary tract results in obstructive uropathy which is one of the leading etiologies of renal failure. So, physicians require accurate and early diagnosis of obstructive uropathy to initiate appropriate treatment of these entities for better prognosis of patient. The purpose of the present study aims to determine the feasibility, accuracy and diagnostic potential of combined static and excretory MR Urography in patients of clinical features of obstructive uropathy with sonographically detected hydronephrosis.
Methods: A cross sectional study of 100 patients were carried in the Department of Radio-diagnosis. The results of MR Urography were compared with the results of post-operative findings and clinical follow-up.
Results: In our study of 100 patients of obstructive uropathy, MRU better depicted mild to severe PCS dilatation, renal and ureteric calculi, impaired renal function, extrinsic ureteric and PUJ obstruction. Static-fluid and excretory MR urography provided a comprehensive evaluation of the kidneys, ureters, bladder, vasculature, and soft tissues in patients with symptoms of obstructive uropathy.
Conclusions: MR urography provided a superior imaging of urinary system dilatation, the site and the etiology of obstruction. In conclusions, static and excretory MRU give both morphological and functional information in a single examination without exposure to ionizing radiation and iodinated contrast agent.

Keywords: Excretory urography, Magnetic resonance urography, Obstructive uropathy, Static-fluid urography

INTRODUCTION

Obstruction to the normal flow of urine due to the presence of structural or functional changes in the urinary tract is known as obstructive uropathy. It occurs due to functional or anatomic lesions that are located anywhere in the urinary tract. Since long various imaging techniques have been described to demonstrate urinary tract. However, only CT urography and MR urography has ability to describe entire urinary system along with its surrounding structures.[1] Hennig J described Magnetic resonance urography (MRU) in 1987 at the University Hospital of Freiburg Germany, as a complementary method to evaluate urinary tract abnormalities.[2] MR urography procedure for the demonstration of the urinary tract is divided into two categories: static-fluid MR urography and excretory MR urography. Static-fluid MR urography is performed by heavily T2-weighted sequences which uses the long T2 relaxation time of fluid in the collecting system to visualize the urinary tract as a static collection of fluid. This can be repeated with cine MR urography to confirm stenosis in ureter. Excretory MR urography is performed with the help of intravenous administration of gadolinium contrast during excretory phase. Diuretic administration can be useful in excretory MR urography in demonstration of non-dilated collecting systems.[3,4] MRU provides a non-invasive visualization not only of the collecting system but also of the renal parenchyma using fast spin-echo pulse sequences as well. The purpose of the present study aims to diagnose cause

of obstructive uropathy and evaluate renal function on MR Urography. And, to confirm the findings of MR urography with intra operative findings & follow-up.

METHODS

This was a cross sectional study performed between October 2015 to September 2017 over 100 patients referred to radio-diagnosis department with clinical features of obstructive uropathy. The study was performed using GE 1.5 Tesla 16 channel- MRI machine. Protocol of this study was submitted to ethical committee of the institute and necessary approval was obtained.

Inclusion criteria

All age group patients with clinical features of obstructive uropathy with pre-detected obstructive uropathy on USG.

Exclusion criteria

- Patients with a cardiac pacemaker
- MRI non compatible stents and implants
- Claustrophobic patients

Those obstructive uropathy patients who fulfil the inclusion criteria and willing to participate in the study were selected on the basis of purposive sampling. A detailed history of each patient was taken. Each patient gave an informed and written consent in local dialect before joining the study after explaining the procedure.

MR urography protocol

Patient was advised to void before procedure. For adult patients, 500cc NS bolus was given immediately before scan. For Paediatric patients, weight-based IVF: 4ml/kg/hr 1st 10kg, 2ml/kg/hr next 10kg and 1ml/kg/hr for each kg above 20kg was given.

Without contrast sequences

- Localizer -Abdomen & Pelvis
- Coronal SSFSE -Abdomen & Pelvis
- Axial T2 Fat Sat-Respiratory Triggered-Abdomen & Pelvis
- Axial T2 Fat Sat-Breath Hold-Abdomen & Pelvis
- Coronal 3D MRCP Thick of Kidneys

PRE contrast sequences

- Ureters and Bladder Thick slab MR Urographic coronal

Post contrast sequences

- 3D Fat Sat GRADIENT Dynamic Axial (pre contrast-during the time of contrast-20 sec and 45 sec acquisitions)
- 3D Fat Sat GRADIENT Axial - Abdomen & Pelvis (Excretory phase)
- 3D Fat Sat GRADIENT Coronal - Abdomen & Pelvis (Excretory phase)

Statistical methods

The data on demography, symptoms of obstructive urography, MRI and final diagnosis were obtained and analysed. Frequency distribution and percentages were obtained for age, gender & symptoms. All the analyses were performed using SPSS version 20.0 (IBM Corp.) software.

RESULTS

A total of 100 patients suspected of obstructive urography on the basis of clinical features and laboratory investigations were examined with MR Urography for the period starting from October 2015 to September 2017. The results have been summarized and presented in tabular forms and charts under different following headings:

Distribution of patients according to age

In present study, majority i.e. 39 (39%) patients were from the age group 31-45 years, followed by 25 (25%) in the age range of 16-30 years, 18 (18%) in the range of 46-60 years and 14 (14%) with more than 60 years. Mean age of patients was 40.5 years.

Table 1: Distribution of patients according to age.

Age (years)	N	%
≤15	4	4%
16-30	25	25%
31-45	39	39%
46-60	18	18%
≥61	14	14%
Total	100	100%
Mean±SD (years)	40.58±16.28	

Distribution of patients according to gender

In our study, 67% of patients were males and 33% were females.

Distribution of patients according to symptoms

Out of the patients studied, maximum i.e. 78 (78%) patients had symptom of flank pain, followed by 44 (44%) with burning micturition, 16 (16%) with hematuria and 14 (14%) with dysuria. Other symptoms nausea, anorexia and pyuria were observed in less than 10% of the cases.

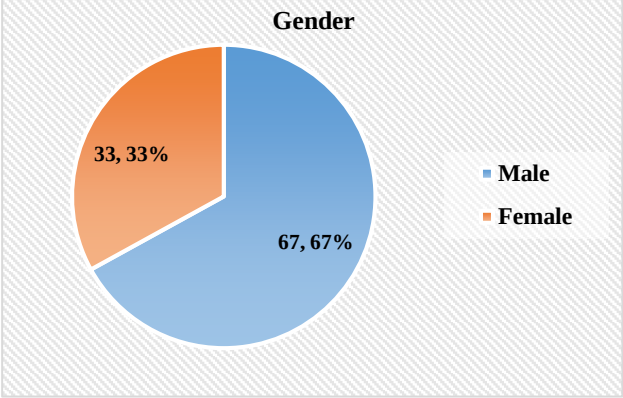

Figure 1: Pie chart showing distribution of patients as per gender.

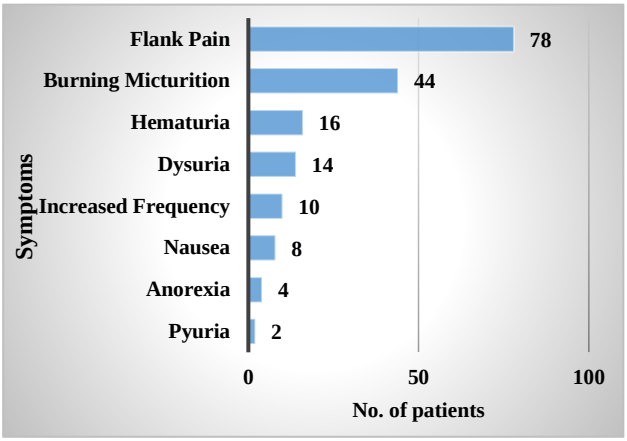

Figure 2: Horizontal bar chart showing number of patients according to symptoms.

Table 2: Final diagnoses of obstructive uropathy in 100 patients.

Causes of Obstructive Uropathy	MRU diagnosis N (%)	Final diagnosis
Renal calculi	32 (88)	36
Ureteric calculi	7 (77)	9
Vesical calculi	13 (81)	16
Ureteric stricture	4 (100)	4
Post radiotherapy fibrosis	1 (100)	1
Horseshoe kidney	1 (100)	1
Renal cell carcinoma	4 (100)	4
Carcinoma bladder	3 (100)	3
Carcinoma cervix	4 (100)	4
Benign prostatic hypertrophy	6 (100)	6
Gravid Uterus	8 (100)	8
TCC of ureter	2 (100)	2
Fibroid	4 (100)	4
Pyelonephritis	2 (100)	2
Total	91 (91)	100

Final diagnoses of obstructive uropathy in all 100 patients

The final diagnoses were based on a combination of all available clinical, imaging, surgical and follow-up data, as was considered appropriate for each case. This is given in Table 3. We observed that, the most common cause of obstructive uropathy was renal calculi (36%) followed by vesical calculi (16%), ureteric calculi (9%), gravid uterus (8%), prostatomegaly (6%), ureteric stricture (4%), renal cell carcinoma (4%), carcinoma bladder (3%), carcinoma cervix (4%), fibroid (4%),2 (2%) case each of TCC of ureter and pyelonephritis and single (1%) case of post radiotherapy fibrosis and horseshoe kidney each. As seen from table 3, MRU was 100% accurate in diagnosing causes of obstructive uropathy, except in cases of calculus where accuracy is about 75-80%.

DISCUSSION

In most cases, hydronephrosis is the consequence of obstruction of the urine flow at any point from the kidney to the bladder. The most severe consequence of obstruction is the renal function deterioration.[5] It is important to differentiate between obstructive and non-obstructive dilatation to choose the proper therapy in order to prevent the loss of renal function.

As par mentioned in literature, static-fluid sequences along with excretory MRU can be useful in the evaluation of obstructive uropathy because T2-weighted images can image dilatation of the obstructed urinary system and excretory MRU can provide information on the functional effects on excretion.[6]

We performed T2W static MR urography sequences in all patients for a detailed anatomical and morphological assessment of the kidney. Then excretory T1 weighted MR urography sequences were taken in those patients where functional assessment of kidney was required and to diagnose the cause of extra-ureteric urinary obstruction.

Most common cause of obstructive uropathy- Calculus

The typical signs of renal calculus include acute frank pain and is seen as filling defect in both Static and excretory urography sequences. Obstructive calculus shows mild to gross hydronephrosis. In present study, the most common cause of obstructive uropathy was Renal Calculi followed by vesical and ureteric calculi. As seen in Figure 1 and Figure 2, calculus is seen as filling defect surrounded by urine with proximal hydronephrosis. MRU has less sensitivity in detecting calculus, but still 51 out of 62 cases of calculus were detected in this study.[7] Excretory urography has a higher sensitivity (96-100%) in diagnosing calculus.[7] However, maximum calculi were detected on static urography.

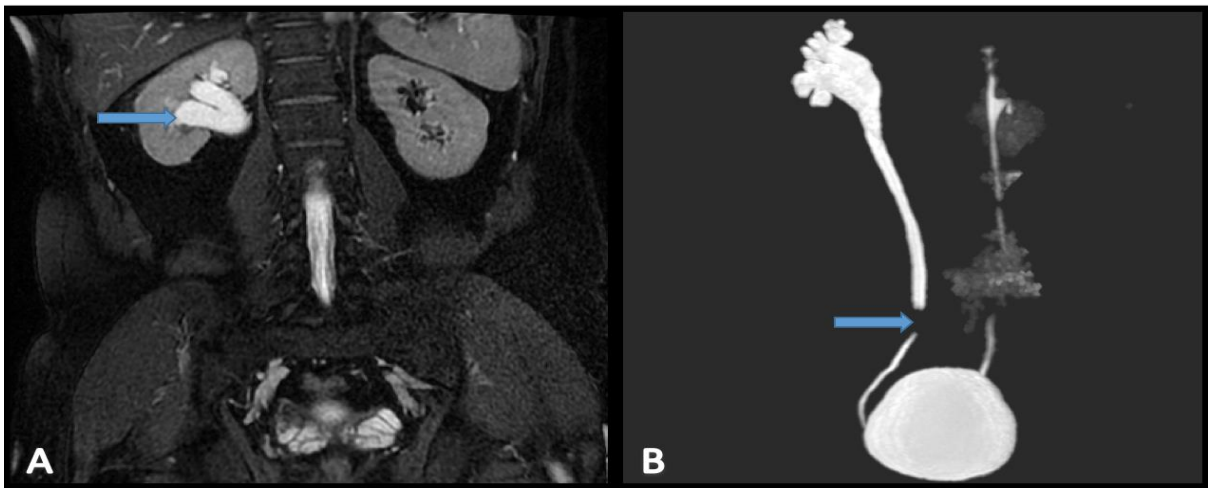

Figure 3: A case of partially obstructing right ureteric calculus.MRI COR. T2WI (A) Right sided hydronephrosis. 3D urogram (B) Signal void in distal one third of Right Ureter- partially obstructing Calculus.

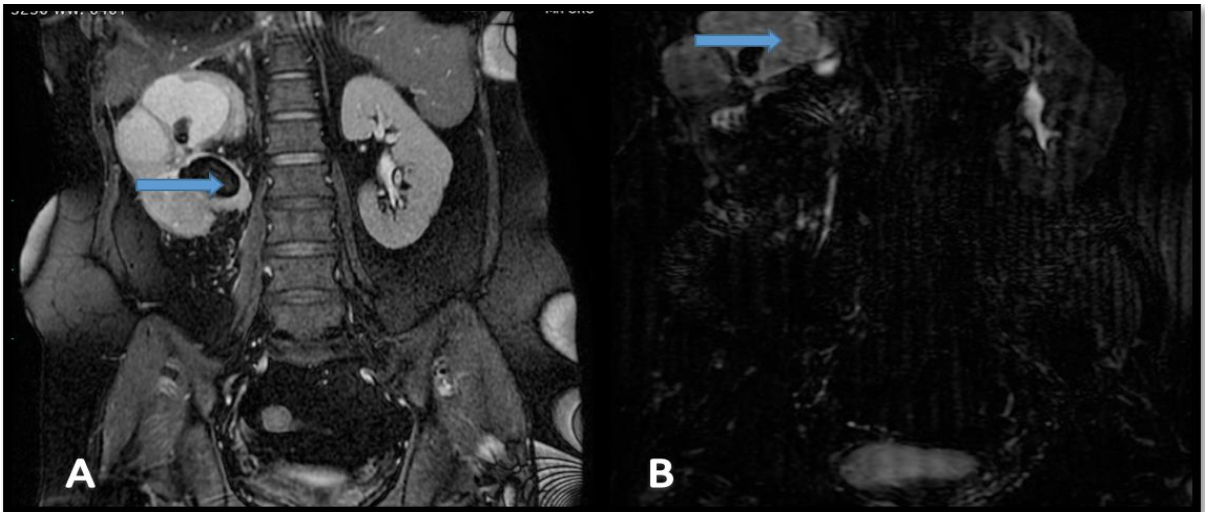

Figure 4: A case of right renal case. MRI COR. T2WI (A) Calculus seen as signal void in PUJ and upper pole of Right Kidney. 3D urogram (B) Right sided hydronephrosis.

Renal carcinoma

The renal carcinoma is one of the most frequent neoplasm found in urography.[8] Urothelial carcinomas can be seen as a sessile filling or polypoid filling.[9] In present study, 4 cases of renal cell carcinoma, 2 cases of ureteral carcinoma and 3 cases of carcinoma of bladder are identified. We used static as well as excretory urography sequences in cases of tumours. This concluded that excretory MR urography is useful in cases of carcinoma, as it can demonstrate kidney function, parenchymal tumour infiltration and extension of lesion.

MR urography in ANC patients

High and repetitive doses of Gadolinium can produce toxic effects on foetus.[10] Though recent studies showed use of Gadolinium is safe during second and third trimester, we had performed static MR urography along with CINE sequences in 8 ANC patients with clinical features of obstructive uropathy.[11] The prime use of diagnostic modality in these patients is to differentiate the ureteral physiological dilation from the pathological.[12-14] Physiological dilation occurs in the third trimester of gestation due to compression of ureter between the psoas muscle and the gravid uterus.[15] Out of 8 ANC patients, physiological dilatation was noted in 6 patients (Figure 4) while calculus was the cause of obstructive uropathy in remaining 2 ANC patients.

Benign prostatic hyperplasia

The physiological cause that leads to the ureterovesical junction obstruction in BPH is still unknown. However,

its diagnosis and early treatment are important because of its association with severe obstructive uropathy and chronic renal insufficiency.[20] We used only static T2W MR urography sequences in 6 patients of BPH to look for hydronephrosis (Figure 10).

MRU delivered 100% accuracy in demonstrating the cause, level of obstruction and grading of hydroureteronephrosis, except in few cases of calculus. It has provided Information about structure, function and integrity of the urinary tract, along with identification of neoplasm and its involvement in adjacent structures. In 6 cases of obstructive urography, MR urography demonstrated the pathology where kidneys were non-functioning. Thus, it is evident that MR urography provides high sensitivity and accuracy in detection of causes of obstructive uropathy.

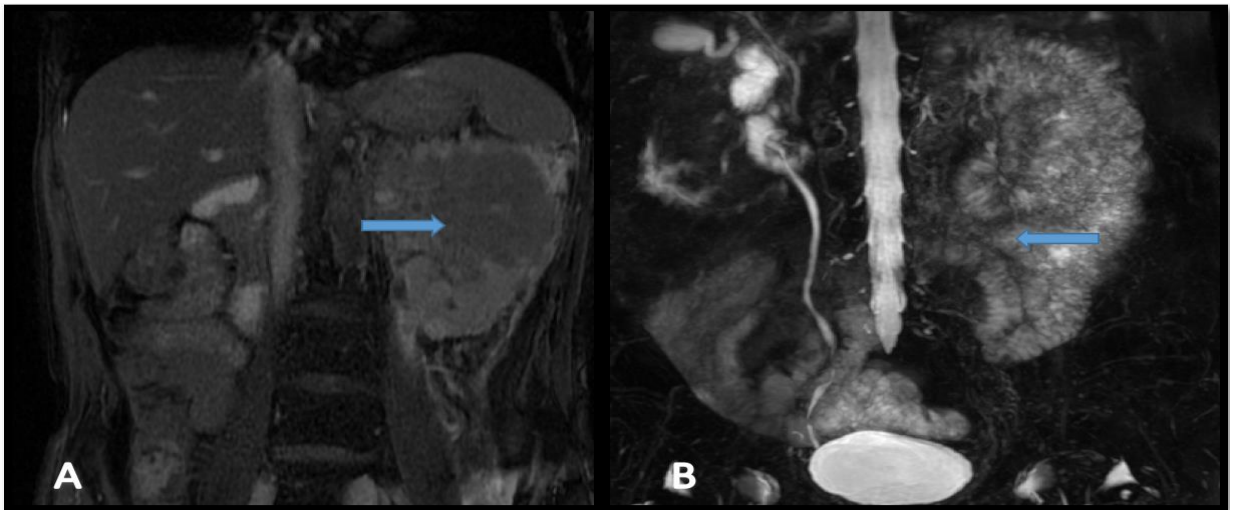

Figure 5: A case of left sided renal cell carcinoma. MRI COR. T2WI (A) A lobulated mass lesion involving upper & mid pole of Left Kidney. 3D urogram (B) Absence of left sided urogram, s/o nonfunctioning left kidney.

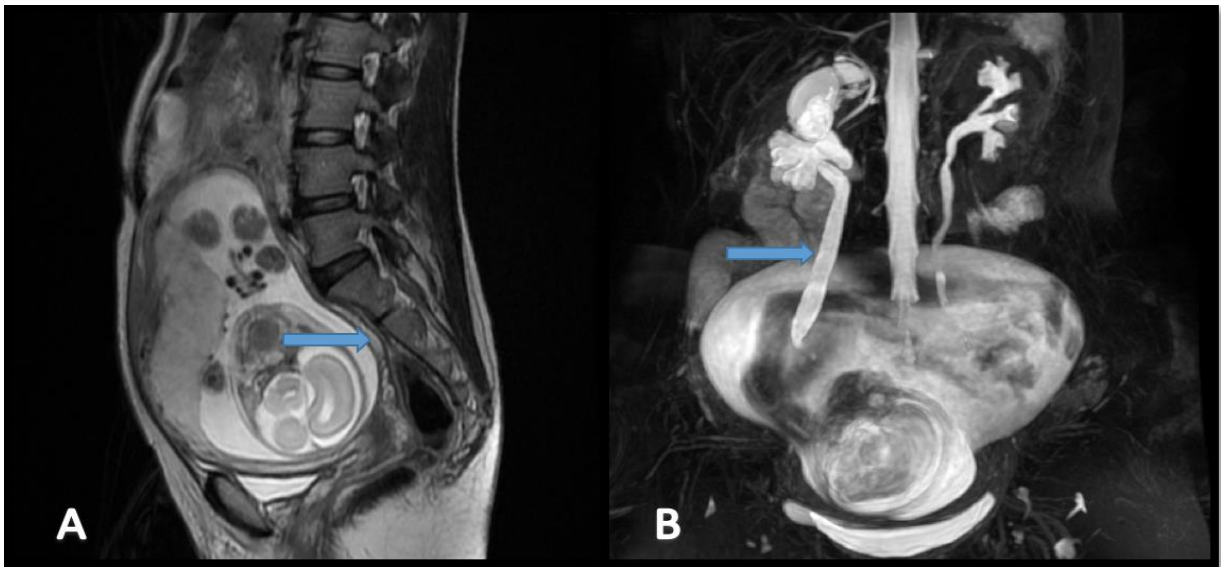

Figure 6: A case of physiological dilatation in ANC. MRI Sag. T2WI (A) Gravid uterus causing compression on right ureter.3D urogram (B) Right sided hydronephrosis with hydroureter.

Pelvic-ureteral junction obstruction

MR urography is useful in the evaluation of congenital anomalies of kidney and pelvic-ureteral junction obstruction.[16-17] It was noticed that in 6 cases main cause of obstruction was PUJ calculus. Another, 2 cases of pyelonephrosis in our study (Figure 7), showed significant cortical thinning with loss of cortico-

medullary differentiation. A single case of horse-shoe kidney (Figure 8) was accurately diagnosed on static MR urography.

Cervical cancer

Women with cervical cancer can often develop hydronephrosis due to tumour or lymph node encroachment, inflammation, or also due to scarring at the pelvic rim.[18] This cancer-related or cancer treatment-related complication is associated with significant morbidity and shortened survival.[19] Thus, early identification of hydronephrosis is important for better prognosis. We used static T2 weighted MR urography sequence along with routine MR pelvis sequences to look for hydronephrosis. Thus 4 cases of Ca cervix (Figure 9) and 4 cases of uterine fibroid are identified as causes of obstructive uropathy. An ultrasound examination can be able to identify obstructive uropathy patients consistently; however, many times it is difficult to find cause of hydronephrosis. A CT scan is effective in evaluating such patients but at the cost of exposing the patient to ionizing radiations. When there are associated congenital anomalies, an MRI can be invaluable in comparison with any other modality of investigation.

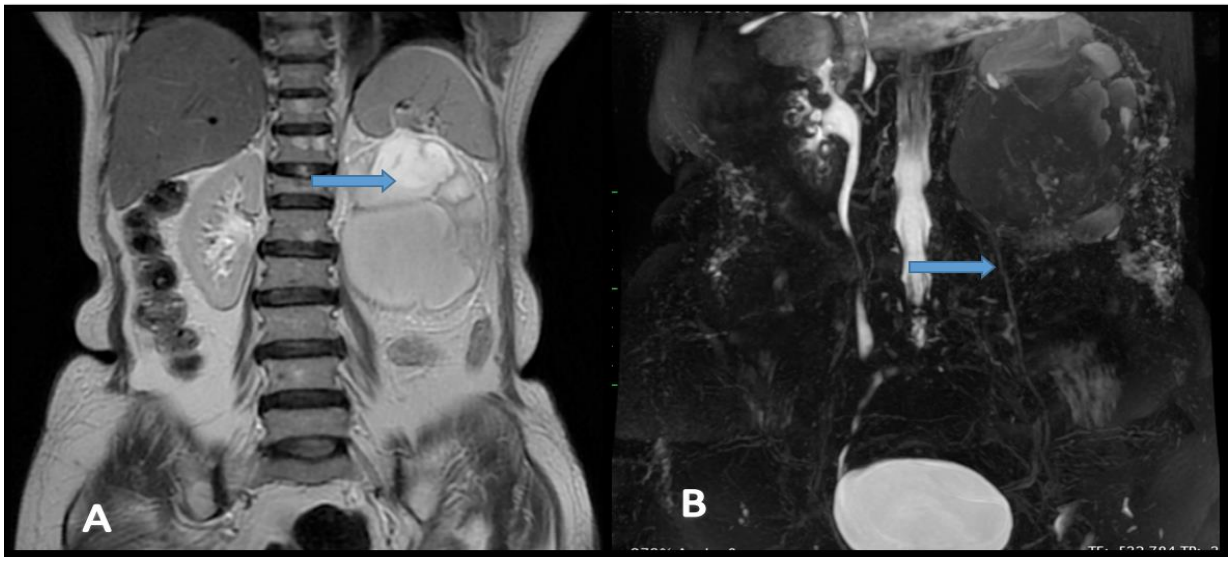

Figure 7: A case of pyelonephrosis.MRI COR. T2WI (A) Gross hydronephrosis with cortical thinning on left side. Fluid-fluid level noted within.3D urogram (B) Absence of left side Urogram, s/o complete obstruction.

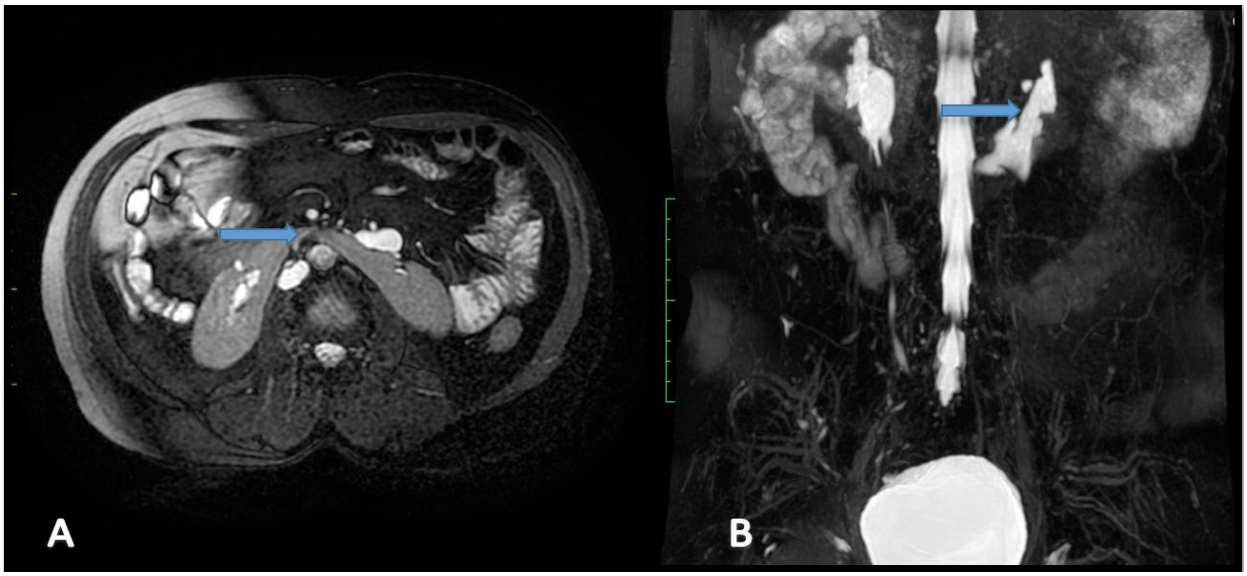

Figure 8: A case of horseshoe kidney.MRI Ax. T2WI (A Lower poles of both kidneys connected with each other s/o horseshoe kidney. 3D urogram (B) Mild bilateral hydronephrosis.

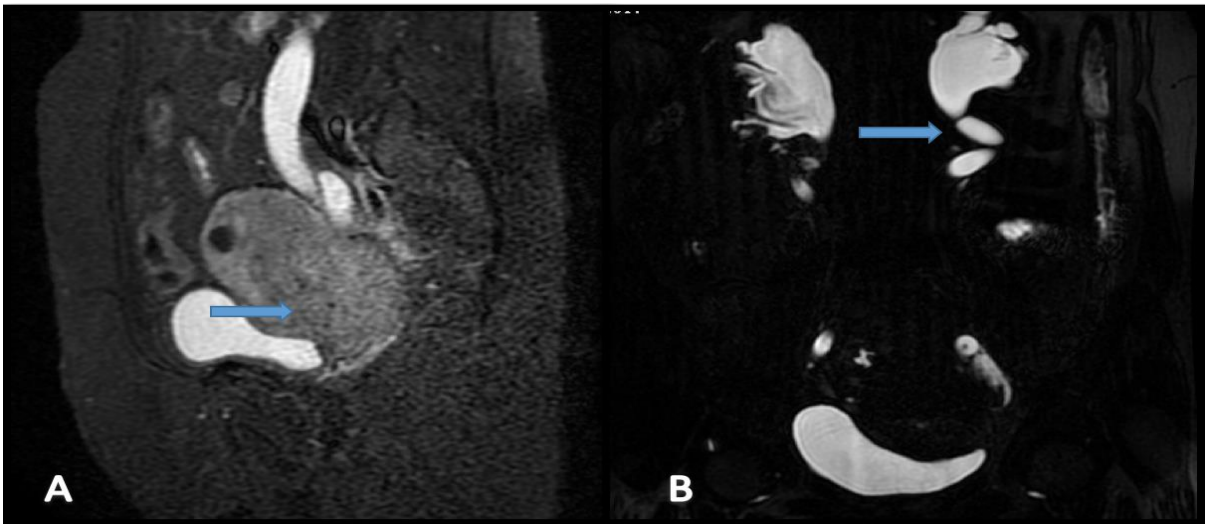

Figure 9: A case of Ca Cervix. MRI sag. T2WI (A) Mass lesion in Cervix causing compression over Ureter. 3D urogram (B) Bilateral hydronephrosis with hydroureter.

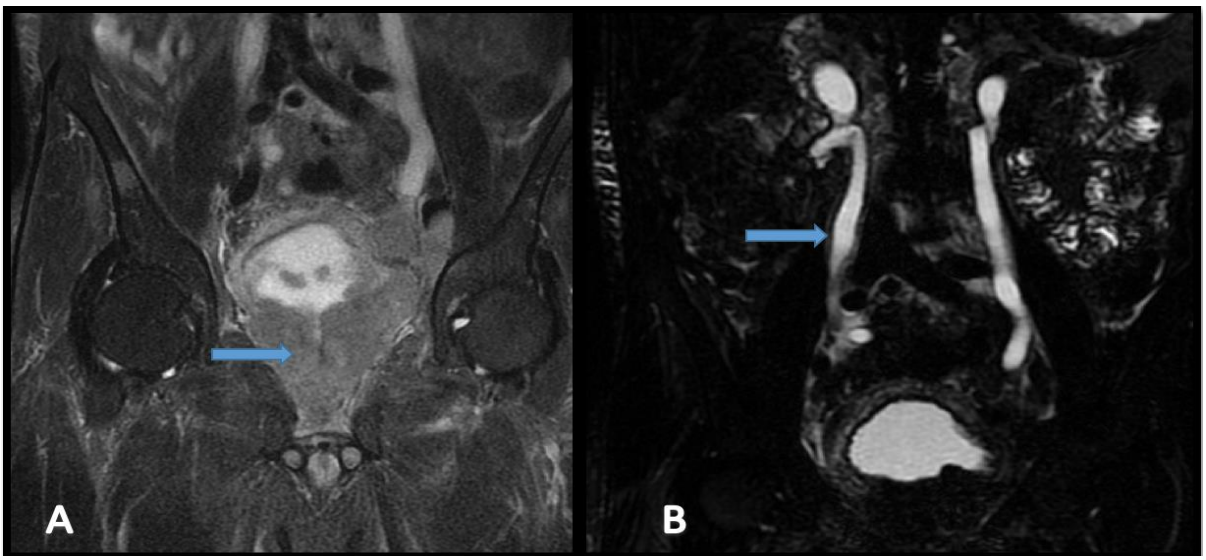

Figure 10: A case of benign prostate hyperplasia. MRI COR. T2WI (A) Enlarged prostate invading into bladder base & compressing bilateral VUJ. 3D urogram (B) Bilateral hydronephrosis with hydroureter.

Table 3: Advantages and disadvantages of MR urography.

Advantages	Disadvantages
Absence of ionizing radiation (useful in patients with transplanted kidneys, children and pregnant women).	Contraindications like metallic implants, foreign bodies
Provides functional information- with gadolinium	High cost (when used with Gadolinium enhancement)
Multiplanar capability.	Limited retrospective reconstruction capability
High contrast resolution.	Low sensitivity in detecting tiny calcifications
Does not depend on renal function.	Time intensive

Currently, the most common pattern of diagnosis of a patient with obstructive uropathy include investigation with clinical examination, laboratory investigations, ultrasound examination, intravenous pyelography (IVP) or CT to detect causes of obstructive uropathy and for the evaluation of renal functions. The information obtained

by ultrasound, IVP and CT can all be obtained by the MRI alone – which does not utilize radiations or iodinated contrast medium. It provides excellent characterization, location and extension of lesion along with the renal function and also status of urinary tract. With this imaging tool, it became easier to detect intrinsic as well as extrinsic lesions causing obstructive uropathy as compare to other imaging modalities due to its superior tissue contrast and resolution. Therefore, now-a day's MRU can become a single stop diagnostic modality for the comprehensive evaluation of urinary obstruction.

CONCLUSION

MR urography has emerged as an essential imaging tool for evaluation of obstructive uropathies. Therefore, we conclude that MRI is the mainstay of imaging evaluation of obstructive uropathies, not only to confirm clinically and sonographically diagnosed obstructive uropathies but also to detect exact level, cause of obstruction and assess the renal function, which have an impact on the planning of treatment. Absence of ionizing radiation and iodinated contrast medium also add ups MRU as the most preferred modality in patients with transplanted kidneys, patients with renal failure, young children and pregnant women. The advantage of MRU over other modalities is that it can demonstrate the pathology even in non-functioning kidneys. Though the cost and availability of MRI maybe a limiting factor, it's excellent soft tissue resolution, multiplanar capability and non-invasive but versatile nature makes MRI to be considered as a comprehensive package for the evaluation of these patients. We presume MRI can replace CT, particularly before planning of management due to its non-radiation nature providing equally sufficient, if not more, information.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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