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Role of Magnetic Resonance Urography In Extrinsic Ureteric Compression

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Abstract: Background: The aim of this case series was to assess the role of MR urography in urinary tract obstruction. Static fluid and excretory urography can be combined with conventional MR imaging for comprehensive evaluation of urinary tract.
Material and methods: Our study was a prospective study of patients presenting with dilated urinary system on sonography. After taking detailed patient history, thorough clinical examination was conducted followed by multimodality imaging approach. The initial imaging work up began with ultrasonography and then Intravenous urography (IVU) followed by MR urography as per protocol in patients whom diagnosis was not clear on IVU. Provisional diagnosis was given and compared with the final diagnosis achieved by surgery or clinical and imaging follow up as applicable.
Results: 10 patients had urinary tract obstruction due to cystocele (2 cases), urinoma (3 cases) carcinoma of sigmoid colon (2 cases), benign prostatic hypertrophy (1 case), leiomyosarcoma of cervix (1 case) and retroperitoneal metastasis of gastric carcinoma (1 case). 9 cases were correctly diagnosed by MRU while 1/2 case of cystocele was identified on IVU. No contrast excretion was found in all cases of urinoma and carcinoma of sigmoid colon. In BPH bilateral hydronephrosis was seen. Leimyosarcoma case showed a soft tissue density in pelvis with bilateral lateral displacement of ureters.
Conclusion: MRU is a non- invasive radiation free imaging modality that offers higher diagnostic ability than conventional urography for morphologic and functional evaluation of urinary tract disorders and can be used as an accurate alternative to IVU.

Keywords: Magnetic Resonance Urography, Urinoma, Cystocele, Leiomyosarcoma

I. INTRODUCTION

Obstructive uropathy refers to structural and functional changes in urinary tract that impedes normal flow of urine. Obstruction to flow of urine with accompanying elevation in urinary tract pressure impairs renal and urinary conduit function. [1]

The defect in function usually disappear completely with early relief of the obstruction, on the other hand chronic obstruction may produce permanent loss of renal mass (atrophy) and excretory capabilities. Hence prompt diagnosis and treatment are of utmost importance.[2]

Common Causes of Urinary Tract Obstruction[2] due to extrinsic causes: Pregnant uterus, Retroperitoneal fibrosis, Aortic aneurysm, Fibroid, Carcinoma of uterus, cervix, prostate, bladder, colon, rectum, lymphoma, Pelvic inflammatory disease, Cystocele.

Intra venous urography has long been the classical gold standard imaging modality for assessing the urinary tract. Over the year the use of excretory urography has become less common as a result of

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cross sectional imaging techniques but it has remained in the general use because low cost ,easy availability and ready acceptance by urologist. Despite of these trends IVU can produce problems in patients who poorly tolerated iodinated contrast media and have renal failure. The use of ionizing radiation especially in children, young adults and pregnant is an issue. A positive result other than radio opaque calculus for all other causes of obstruction dictates further imaging. It is possible to avoid multimodality work up and its associated cost if similar information can be available from a single modality.

Development of magnetic resonance imaging of static fluid led to emergence of Magnetic resonance urography (MRU) as potential imaging modality for urinary system. The accuracy in the detection of urinary tract dilatation and the localization of the level of obstruction is excellent. MR Urography has been shown to be highly sensitive to the diagnosis of urinary tract obstruction. Demonstration of peri-nephric and peri-ureteric edema in obstruction helps in the differentiation of acute from chronic urinary obstruction. T_2W MR-Urography may be considered in circumstances when there are contraindications to IVU (allergy lo contrast medium, severe renal failure), impairment of renal excretion and failure to locate the level of obstruction. The absence of ionizing radiation favours the promotion of this procedure especially to study hydroureteronephrosis during pregnancy.

Further studies have shown that although ultrasound has a very good sensitivity in detecting features of renal obstruction, in certain cases it fails to delineate the level of obstruction, especially in cases of mid-ureteric pathology. In these cases MR Urography has been able to accurately demonstrate the level of obstruction along with giving a better anatomical detail.

Magnetic resonance urography is performed by pursuing two different imaging strategies. On one hand, heavily T2-weighted turbo spin- echo sequences are employed for obtaining unenhanced images of the urinary tract. On the other, the T1-weighted MR urographic technique or **e**xcretory MR urography is performed during the excretory phase of enhancement after the intravenous administration of gadolinium-based contrast material; thus, the patient must have sufficient renal function to allow the excretion and even distribution of the contrast material. Diuretic administration is an important adjunct to excretory MR urography, which can better demonstrate nondilated systems.

II. METHODS

The present study was a prospective study conducted in the Department of Radiodiagnosis and Imaging, Pt B.D. Sharma, PGIMS, Health University, Rohtak. The patients with dilated urinary system on sonography were included. Patients with renal failure, history of contrast hypersensitivity and exclusion criteria for MRI were not included in the study. Informed consent was taken. After taking detailed patient history, thorough clinical examination was conducted followed by routine lab investigations including kidney function test.

Sonography of the KUB region was done by convex probe (3 to 8 MHZ) on Siemens sonography machine. Intravenous pyelography was done as per following protocol. Preliminary scout image of KUB was taken. Contrast media was injected nephrographic image was taken after a minute. A KUB image was taken after 5 minutes of contrast administration and abdominal compression was applied. Pyelographic image was taken 5 min. after compression and ureter bladder image (full length) was taken 15 min after contrast and immediately after release of compression. Then post-micturition full length image was done. Optional delayed images were taken depending on contrast excretion.

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MR urography was conducted in appropriate patients by Philips Gyroscan Nova 1.5 Tesla MRI. Patient was examined in supine position using standard body coil. All patients were examined under T1/TFE- axial and T2 weighted sSSH/TE80 axial, coronal and saggital, MRCP- MS-coronal and MRCP radial. Then patients were given IV furosemide (diuretic) 0.1 mg/kg and 30-60 seconds after it Gadolinium based contrast agent was given at a dose of 0.1 mmol/kg after skin testing. Then immediately T1/TFE and CE Angio (3D T1/FFE) sequence was conducted. CE Angio was repeated at 5, 10, 15, 20 minutes. The diagnosis based on IV urography and MR urography individually and collectively was evaluated by calculating sensitivity and specificity against final diagnosis achieved on surgical intervention and clinical follow up.

III. RESULTS

In the present study this heterogeneous group of varied etiologies had 10 patients in the age ranging from 30 to 85 years. Males and females were present in equal number. There were 5 patients with B/L involvement. They were cystocele with B/L hydroureternephrosis in two, benign prostatic hypertrophy in one case , B/L hydroureteronephrosis due to compression from leiomyosarcoma of ant.cervical lip in one and retroperitoneal metastasis from carcinoma stomach in one case. Unilateral involvement was seen in urinoma of pelvis of left kidney in three cases and left sided hydroureteronephrosis due to growth from sigmoid carcinoma compressing the left ureter in two cases. In this group total of 15 urinary tracts were involved. The predominant clinical features were flank pain in 8 cases (80%), followed by lump in the flank in 3 cases (30%), blood in stool in 2 cases (20%) of carcinoma colon and dysuria in the single patient of BPH (10%).

A. Sonography

In both cases of cystocele b/l hydroureteronephrosis was seen.

2 cases of urinoma had h/o penetrating injuries with renal truama. In first case, a cystic lesion on anterior aspect of hilum of left kidney was seen on sonography indistinguishable from renal pelvis with caliectasis where provisional diagnosis of PUJ obstruction was made. On the 2nd and 3rd case, large cystic lesion communicating with renal pelvis was seen in left lumbar region with caliectasis.

In BPH B/L hydroureteronephrosis was seen with thick trabeculated UB. Prostate was enlarged (volume 80cc) and post void residual volume was 170 cc.

The case of leiomyosarcoma presented as a large heterogeneously hypoechoic lesion in anterior wall of cervix where the diagnosis of cervical fibroid was made on USG. B/l hydronephrosis was seen with dilated ureters till upper end of the mass.

The case of retroperitoneal metastasis of carcinoma stomach was seen as b/l hydronephrosis with dilation of upper ureter. Mid ureters could not be traced and cause was not identified.

In case of CA sigmoid a hypoechoic mass with gut signature was seen in sigmoid colon compressing the left ureter with proximal hydroureteronephrosis. No luminal irregularity of ureter was found.

B. Intravenous Urography

Only one case of cystocele was correctly diagnosed by IVU. In both the cases of cystocele there was B/L hydronephrosis with dilated ureters up to pubic symphysis where there was gradual tapering of their lumen. Urinary bladder was seen below pubic symphysis in one case. In all the cases of urinoma no contrast excretion was seen. One case showed only nephrogram while other two had neither excretion nor nephrogram. In the

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BPH B/L hydronephrosis was seen. In case of leiomyosarcoma, on plain X- ray KUB a soft tissue shadow was seen in pelvis. B/L dilated ureters were displaced laterally and showed gradual tapering just above the soft tissue shadow with persistent hold up of contrast. In both the cases of carcinoma sigmoid colon and only nephrogram without contrast excretion was seen. In case of retroperitoneal metastasis of Carcinoma stomach, b/l hydronephrosis with dilated ureters till pelvic brim were seen.

C. Magnetic Resonance Urography

Correct diagnosis was achieved in all 10 cases by both static fluid and excretory MRU.

In **cystocele** uterus was present caudal to the pubic symphysis along with urinary bladder in one case, other case urinary badder was compressed between low lying uterus and pubic symphysis. In static fluid MRU B/L dilated pelvicalyceal systems with dilated ureters were seen till pubic symphysis where they tapered gradually. There was hold up of contrast seen in excretory MRU.

Urinomas were best depicted in static fluid MRU as cystic lesions communicating with urinary tract and compressing them in the retroperitoneum. In first case it communicated with the renal pelvis simultaneously compressing it. In second and third case the cyst was large and communicated with the calyces. In excretory MRU there was contrast excretion in pelvicalyceal system, however no contrast was seen in the urinomas till 24 hour in second and third case. (Figure 1) The first case showed contrast in urinoma on delayed imaging.

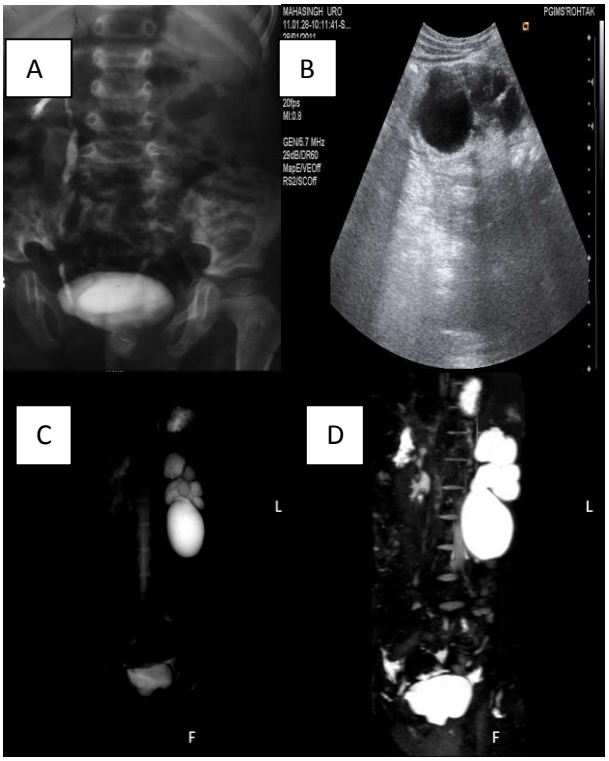

Figure 1 Urinoma pelvis of left kidney (A) IVU image at 15min, showing normal pelvicalyceal system of right kidney. No contrast excretion or nephrogram is seen in left kidney. (B) USG image showing a cystic lesion in anteromedial aspect of left kidney with dilated calyces. (C) T2W MIP Image, (D) Coronal T2W image shows a cystic lesion communicating with the pelvis of left kidney.

In the **prostatic hypertrophy** along with B/L hydroureteronephrosis, enlargement of median lobe of prostate and thickening of urinary bladder wall was seen in both T1W and T2W sequences. There was normal contrast excretion in both kidneys.

In the **leiomyosarcoma** a large heterogeneous lesion was seen arising from anterior lip of cervix displacing UB anteriorly. B/L ureters were displaced laterally and showed smooth tapering due to compression by the lesion. On T2W the mass was heterogeneously hyperintense and hypointense on T1W with thick irregular peripheral enhancement. B/L

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hydroureteronephrosis was seen with hold up of contrast in excretory MRU. (Figure 2)

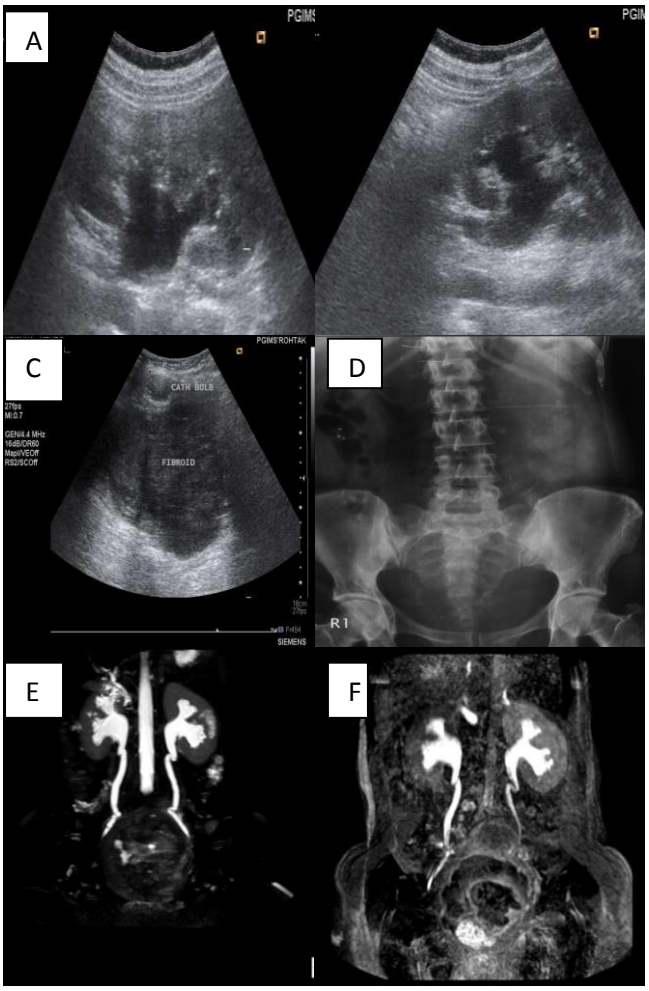

Figure 2 Case of leiomyosarcoma of cervix (A), (B) USG images showing right and left kidney respectively demonstrate dilation of pelvicalyceal system and upper ureter. (C) USG image showing hypoechoic lesion in anterior wall of cervix. (D) Plain X- Ray KUB showing soft tissue shadow in pelvis. (E) T2W MIP and (F) T1W MIP with contrast showing bilateral hydroureteronephrosis and both the ureters are deviated laterally and taper gradually above the mass.

Thickening of sigmoid colon and rectum was seen in both the cases of **sigmoid colon carcinoma**. A heterogeneous mass was seen in continuity of sigmoid colon which was hypointense on TIW, hyperintense on T2W with good enhancement. The mass encased the left ureter with narrowing of its lumen. Compression of ureter was smooth with preservation fat planes. On excretory MRU contrast excretion was seen at 6 hour demonstrating the ureteric lumen which showed smooth tapering without any irregularity. (Figure 3)

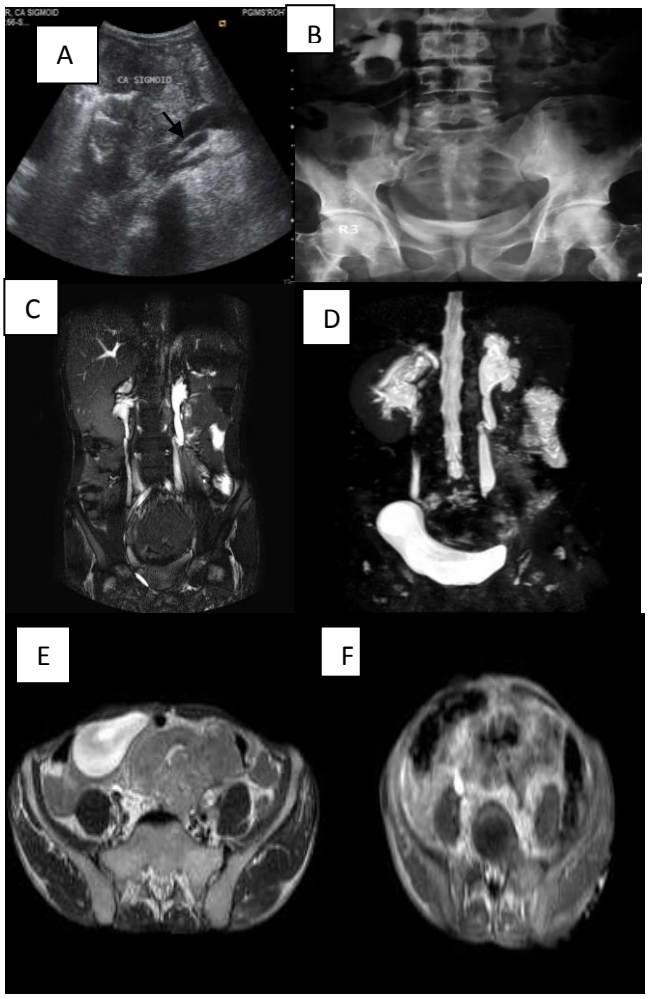

Figure 3 Carcinoma sigmoid colon compressing left ureter (A) US image showing smooth tapering of left ureter (arrow) due to compression by a hypoechoic mass with gut signature. (B) IVU image at 15 min showing left kidney without excretion of contrast. (C) Coronal T2W and (D) T2W MIP showing dilated pelvicalcyceal system and ureter of left kidney. Smooth tapering without luminal irregularity is seen in left ureter. (E) T2W axial, (F) T1W axial with contrast showing a large soft tissue mass hyperintense on T2, hypointense on T1, with enhancement and gut signature in

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relation to sigmoid colon .The mass compresses the left ureter.

Bilateral hydronephrosis with dilatation of upper and mid- ureters was found with smooth tapering at level of pelvic brim in case of **carcinoma stomach metastasis**. However no filling defect or surrounding mass could be depicted. Ureteral stenting was done. Patient later presented with bowel obstruction and laparotomy was done which showed retroperitoneal metastasis obstructing the large bowel as well as ureters.

TABLE I Sensitivity of US, IVU AND MRU in Extrinsic Ureteric Compression

	Final Diag	USG Diag	Sens %	IVU Dig	Sens %	MRU	Sens %
Total	10	4	40	1	10	9	90

IV. DISCUSSION

Urinary tract obstruction affects patients of all ages and it predisposes to urinary tract infection, urinary calculi formation, urinary tract damage and renal failure. As it is one of the few causes of potentially reversible renal damage, early and accurate diagnosis helps in preventing the renal damage and its progress to renal failure. The present study was performed to assess sensitivity of both MR urography and IVU for the morphologic and functional study of the urinary system. Magnetic resonance imaging (MRU) technique has partially replaced IVU as it provides a better assessment of the retroperitoneum and renal parenchyma and does not require exposure to ionizing radiation or administration iodinated contrast media.

In our study there were 10 patients with various etiologies presenting as extrinsic compression of urinary tract.

A. IVU

In the present study on IVU we could diagnose only one case of cystocele. In all other cases definite diagnosis could not be made due to non-excretion of contrast or inability of IVU to depict lesions lying outside urinary tract.

In both the cases of cystocele there was B/L hydroureteronephrosis with dilated ureters up to pubic symphysis where gradual tapering of their lumen was seen. Urinary bladder was seen below pubic symphysis in one case. Similar features were suggested by Tubaro et al in their study found that in all cases of cystocele on IVU or cystourethrogram UB had descended below pubococygeal line [3].

In all the cases of urinoma no contrast excretion was seen.

In the BPH B/L hydroureteronephrosis was seen. Bundrick et al in their study detected upper urinary tract complications like hydronephrosis in patients with BPH[4].

On plain X ray KUB a soft tissue shadow was seen in pelvis in case of leiomyosarcoma. On IVU B/L dilated ureters were displaced laterally and showed gradual tapering just above the soft tissue shadow with persistent hold up of contrast suggesting compression by the mass.

In both the cases of carcinoma sigmoid colon and only persistent nephrogram was seen without excretion contrast.

B. MRU

In our study majority patients (90%) with extrinsic compression of urinary tract were correctly diagnosed on MRU with depiction of the cause of obstruction.

In both the cases of **cystocele,** urinary bladder was descended below pubococygeal line. In one patient uterus and urinary bladder prolapsed through vagina completely (procidentia). Both static fluid and excretory MRU depicted the BL dilated urinary tract. B/L ureters were compressed by uterus at the pelvic outlet producing smoothly tapered ureter on MIP images. Similar features were suggested by Tubaro et al [3].

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In our study on static fluid MRU **Urinomas** were depicted as cystic lesions communicating with urinary tract and compressing them in the retroperitoneum. The urinomas communicate with the pelvis or calyces of kidneys in all cases. Mclnerney et al, Sorgmanet al, Ross et al in their studies reported similar features of urinoma like retroperitoneal location, communication with urinary tract, renal displacement, however contrast filling of urinoma was reported in delayed films[5,6,7].

In our study on MRU B/L hydroureteronephrosis, enlargement of median lobe of prostate and thickening urinary bladder wall was seen in the patient of benign prostatic hypertrophy with both T1W and T2W sequences. There was normal contrast excretion in both kidneys. Similar findings were reported Louca et al and Bundrick et al in the other studies which suggest that assessment of upper urinary tracts were mandatory in BPH before surgical interventions to rule out associated complications[4,8].

In the **leiomyosarcoma** a large heterogeneous lesion was seen arising from anterior lip of cervix displacing UB anteriorly. B/L ureters were displaced laterally and showed smooth tapering due to compression by the lesion. On T2W the mass was heterogeneously hyperintense and hypointense on T1W with irregular peripheral enhancement. B/L hydroureteronephrosis was seen with hold up of contrast in excretory MRU. Pattani et al conclude that malignant degeneration should be considered on MR images of any degenerated leiomyoma showing an irregular contour [9]. Shapeero et al in their study reported that the massiveness of the tumors on initial presentation suggested the diagnosis of mixed mullerian sarcoma[10]. Similar features of leiomyosarcoma were also reported in other studies[11,12].

On MRU thickening of sigmoid colon and rectum was seen in both the cases of **sigmoid colon carcinoma**. A heterogeneous mass was seen which encased the left ureter with narrowing of its lumen. Compression of ureter was smooth with preservation fat planes. On static fluid MRU the dilated ureter was seen proximal to the growth without any luminal filling defect. On excretory MRU contrast excretion was seen at 6 hour demonstrating the ureteric lumen which showed smooth tapering without any irregularity. El-Diasty et al described the MRU features of extrinsic compression as a concentric stricture with gradual tapering of the ureteral wall or an abrupt reduction of the ureteric calibre[13]. Similar features colon carcinoma was also seen in other studies[14,15,16].

The diagnosis of retroperitoneal metastasis from carcinoma stomach could not be made on MRU. Y. Saida et al[17] described a case series of obstructive urography due to gastric malignancy in which pre-operative diagnosis was possible only in few cases.

In our study MRU successfully diagnosed 9 cases of extrinsic ureteric compression with 90% sensitivity while only one out of 10 cases was detected by IVU with sensitivity of 10%. Detection rate was high in MRU because it was a cross sectional study where complete anatomy of region of interest could be illustrated. Rames et al in their study emphasized that MRU provided a better assessment of the retroperitoneum and renal parenchyma .Similar results were also reported in other studies. MRU had 100% detection rate in diagnosing extra-ureteric tumours in study of study of Jung et al [18].

V. CONCLUSION

The main cause of non-detection with IVU was the absence of contrast excretion and its inability to assess the pathologies lying outside urinary tracts due to lack of 3- dimensional viewing. MRU circumvented these loop holes of IVU because as a cross sectional study it revealed the

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complete morphology of the region of examination and to depict the anatomy it was not dependent on function of kidneys. MRU provides comprehensive assessment of kidneys, ureters, urinary bladder, vasculatures and soft tissue in such patients. We conclude that magnetic resonance urography can be used as an accurate alternative to conventional excretory urography.

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