Magnetic Resonance Urography in Obstructive Uropathy

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Abstract

Background: Urinary obstruction is one of the few reversible causes of renal failure. Early diagnosis and treatment can salvage the kidney. Presently intravenous urography, ultrasonography, computed tomography and magnetic resonance imaging are in vogue to detect the cause and demonstrate the site of obstruction.

Methods: An evaluation of imaging technique in obstructive uropathy was undertaken in a group of 25 patients.

Result and Conclusion: Magnetic resonance urography delivered highest accuracy amongst the techniques studied.

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Key Words : Magnetic resonance urography

Introduction

Intravenous urography has been used as the primary imaging technique for the diagnostic evaluation of urinary tract for several years. With development of more competitive imaging modalities [1] and apprehension about the adverse effects of contrast media and radiation, intravenous urography is going to disrepute. Conditions that arise outside the urinary tract also result in urinary tract obstruction and may go unnoticed with intravenous urography alone. It is therefore important, to determine the cause and level of obstruction by an effective protocol.

Material and Methods

Patients with complaint of vague abdominal pain were examined by ultrasonography (USG) and 25 of those with features of dilated pelvi calyceal system were taken up for further evaluation by intravenous urography (IVU), computerised tomography (CT) and magnetic resonance urography (MRU). Images were reviewed by radiologists who were blinded to the results of the other investigative modalities.

Ultrasonography of the kidneys, ureter and bladder region was done with a 3.5/5 MHz curved array probe of LOGIC 200 pro series - GE system. Patients were examined with full bladder. If there was a suspicion of hydronephrosis, (Table 1) then they were re-examined after evacuation of the bladder. This was done to exclude the possibility of pseudo-hydronephrosis [2]. The proximal ureter was best visualised in a coronal oblique view, using the kidney as a window. The distal ureter was seen supra-pubically through the full bladder. The urinary bladder was scanned trans-abdominally.

After obtaining the plain radiograph of the abdomen in an

adequately prepared patient, ionic/ non-ionic contrast medium (Trazograf 76%/ Omnipaque 300) was injected intravenously (0.3-0.6 mg/Kg body weight) for intravenous urography. Non-ionic contrast medium (Omnipaque 300mg/ml) was used in children, elderly, asthmatics, diabetics and other high-risk patients. Serial radiographs of the abdomen were obtained at five minutes, 15 minutes and 30 minutes after intravenous injection of contrast in supine position. If no obstruction was detected, the examination was concluded with a full and post void radiograph of the bladder. Additional delayed radiographs were obtained up to 24 hours when indicated.

CT was performed on single slice helical system (Hi Speed CT/I GE). Non-contrast CT (NCCT) was done to start with which was followed by contrast enhanced CT (CECT). Ionic / non-ionic intravenous contrast medium (Trazograf 76% / Omnipaque 300) was administered as the bolus dose of 0.3 - 0.6 mg per Kg body weight by hand injection. Consecutive slice thickness of 4-10 mm axial scans was obtained. Delayed scans were done depending upon the cases. Oral water soluble iodinated contrast was administered, when staging of disease in carcinoma cervix or urinary bladder was required. Diagnosis of calculus was made when high-density lesion (HU 200-600) was detected along the course of the urinary tract. The level of obstruction was established after studying the serial scans and reconstructed 3D images.

MRU was performed using the 1 Tesla Magnetom Harmony Siemens Medical System. In order to demonstrate the water content of the urinary tract, heavily T-2 weighted pulse sequences were used. RARE imaging or Turbo spin-echo sequences were used as options, for obtaining images in short data acquisition time. Combination of a single shot TSE and a half-Fourier data (HASTE sequence) improved the contrast between urinary tract and retro-peritoneum. For contrast enhanced studies, Omniscan (Gadodiamide Gd

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DTPA-BSA) was given in a dose of 0.1 mmol per kilogram by hand injector. This helped to demonstrate the extent and nature of the neoplastic and inflammatory pathology. Post contrast T1 weighted sequences were repeated in coronal and transverse planes. The loop diuretic (frusemide 5-10mg) was used only in seven cases in which T2 weighted sequences could not demonstrate morphology of pelvicalyceal system very well [3]. Post processing was performed using the maximal intensity projection (MIP) algorithm. Signal void area surrounded by the hyper intense urine within the urinary tract would indicate presence of a calculus. However these findings are not specific for a ureteral stone and may represent blood clot, gas, fungal ball and sloughed papilla.

Results

The commonest cause of hydronephrosis in this study, was urinary calculi. The causes for hydronephrosis in this series are listed in Table 2 and the efficacy of various imaging modalities in detection of the cause is depicted in Table 3.

Two out of fifteen patients (13%) who were administered ionic contrast media had minor allergic reactions in the form of transient rashes and itching. Ten cases who were administered non-ionic contrast media and non-ionic gadodiamide injection did not have any adverse reaction.

Discussion

Twenty five cases of obstructive uropathy were

Table 1

Hydronephrosis as detected by various imaging modalities

Grade of hydronephrosis	USG	IVU	CT	MRU
Absent	Nil	01	00	00
Mild	05	05	06	06
Moderate	16	15	15	15
Severe	04	04	04	04

Table 2

Distribution of various causes of obstructive uropathy

Cause of hydronephrosis	Number	Percentage
Urinary calculi	17	68
PUJ obstruction (congenital)	3	12
Ureteric stricture	2	8
Carcinoma bladder	1	4
Carcinoma cervix	1	4
Psoas abscess	1	4
Total	25	100

Table 3

Detection of cause of obstruction by various imaging modalities

Obstruction Cause	Number of cases	Detected by USG	Detected by IVU	Detected by CT	Detected by MRU
Calculus	17	14 (82%)	15 (88%)	17 (100%)	14 (82%)
Congenital PUJ obstruction	03	03 (100%)	02 (66%)	02 (66%)	03 (100%)
Neoplastic	03	02 (66%)	01 (33%)	02 (66%)	03 (100%)
Others	02	01 (50%)	00 (00%)	01 (50%)	02 (100%)
Exact level	25	22 (88%)	17 (68%)	23 (92%)	25 (100%)

evaluated by four different modalities to assess the grade of hydronephrosis, cause of obstruction and level of obstruction [1,5]. Calculus was detected by NCCT in 17 out of the 25 patients which was the most common cause of hydronephrosis in this study group. USG has been the initial investigation for evaluation of acute flank pain. Calculi were missed during USG in three patients, as they were lodged in the mid ureter, lower ureter and vesico-ureteric junction respectively. The fallacy was due to the small size and the bowel gas, which made visualisation difficult. USG helped to diagnose the grade of hydronephrosis very precisely in all the twenty-five cases. All three cases of PUJ obstruction were evaluated by USG and the level of obstruction was detected correctly. However it was unable to provide information on functional aspect and whether the obstruction was complete or incomplete. USG detected neoplasm in two cases and failed in one with a malignant ureteric stricture. It could not define the involvement of VUJ in the case with carcinoma urinary bladder.

The site and size of the calculus was clearly defined during IVU, however it failed to demonstrate the aetiological component in two cases, where in one, the calculi was at the VUJ and in the other it was lodged in the upper ureter causing partial obstruction. Another vital aspect was the ability to determine the functional aspect of the obstruction. IVU has an advantage over the other modalities in determining whether the PUJ obstruction is partial or complete. IVU has inherited disadvantage that it provides limited information on mural pathology and none on extramural pathology.

All seventeen cases of calculi were detected by NCCT. Associated findings like hydronephrosis, hydroureteronephrosis, perinephric stranding and ureteric edema were also demonstrated. However it provided limited information about the ureteric wall and intra-luminal pathology [4]. It had similar limitations of radiation exposure and contrast allergy as in IVU. CECT helped to demonstrate the course of the ureter in relation to the suspicious high attenuation structures.

The advantage of MRU over other modalities was that it could demonstrate the pathology even in nonfunctioning kidneys [6, 7]. Visualisation of urine filled ureter below the site of obstruction and existence of any aberrant vessel can be picked up with ease by MR

Fig. 1 : 22 years old female patient presented with flank pain and fever. Clock wise from top left : IVU, axial CT, MRU and sagittal MR section. MRU precisely demonstrated obstructive uropathy due to psoas abscess.

angiography if combined with the MRU. The site of obstruction was clearly demonstrated (Fig.1) but identification of the stone was difficult with MRU. Sensitivity and specificity of MRU for the demonstration of calculi increased with contrast enhanced T1-weighted urography. Maximum intensity projection (MIP) images selectively displayed high signal intensity pixels. Besides in gadolinium excretory urography, extra urinary fluid collections could not degrade the quality of MIP images because the signal of un-enhanced intestinal water was always hypointense on T1-weighted images. The low sensitivity of MRU towards detection of calculus could be related to the size and the scanning parameters. The characterisation of tissue, site of origin and extent of mass was depicted well with the use of contrast. Visualisation of both intrinsic as well as extrinsic obstructive lesions was easy with MR urography (Fig. 1). Information about structure, function and integrity of the urinary tract, along with identification of hematoma, neoplasm, abscess or oedema, if any, is possible with MR. Other imaging modalities may have these limitations at times due to inferior tissue contrast

and resolution.

To conclude IVU is safe, inexpensive and easily available for evaluation of functional aspect of obstruction. USG is primarily used to investigate patients with acute flank pain and mass in renal area. The findings will require confirmation by other modalities.

NCCT is the ideal modality to investigate patients of suspected calculi. Radiation exposure and allergy to the contrast agent are the limiting factors in CT. CT may not demonstrate the mural pathologies of ureter. However it demonstrates the level of obstruction.

MRU delivered highest accuracy to demonstrate the cause, level and degree of obstruction and hydronephrosis. It has a lower sensitivity in detection of urinary calculi as compared to other modalities. MRU is a better modality for evaluation of malignant as well as benign causes of obstruction due to its multi planar capability and superior soft tissue contrast. MRU could be the imaging modality of choice in patients at risk of radiation like children, young adults and pregnant women.

Conflicts of Interest

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Intellectual Contribution of Authors

Study Concept : Col KK Sen

Drafting & Manuscript Revision : Col KK Sen

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