

MAGNETIC RESONANCE UROGRAPHY IN EVALUATING PATIENTS WITH CLINICALLY SUSPECTED OBSTRUCTIVE UROGRAPHY

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ABSTRACT

BACKGROUND

Magnetic Resonance (MR) Urography comprises an evolving group of techniques with the potential for allowing excellent noninvasive evaluation of abnormalities of the urinary tract. MR urography is clinically useful to evaluate patients with clinically suspected urinary tract obstruction particularly beneficial in paediatric or pregnant patients or when ionizing radiation is to be avoided.

The objectives of the study are- to find out the aetiological factors causing obstructive uropathy by MR urography and a detailed study of the aetiological factors in all cases.

MATERIALS AND METHODS

The study was carried out over a period of 18 months. A total of 35 patients were included in this study with ages between 14 and 70 years (average age 35 years). The patients were selected on the basis of sonological findings of hydronephrosis. The patients were then subjected to IVU followed by static and dynamic MRU. The results obtained were then compared followed by inferences.

RESULTS

MRU has superior sensitivity in the diagnosis of urinary tract obstruction. MRU is safer than IVU due to lack of iodinated contrast material and without using contrast material so having less contrast related events. It has a lower sensitivity in detection of urinary calculi as compared to other modalities.

CONCLUSION

MRU could be the imaging modality of choice in patients at risk of radiation like children, young adults and pregnant women.

KEYWORDS

Intravenous Urography, Magnetic Resonance Urography, Obstructive Uropathy.

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BACKGROUND

Standard intravenous urography (IVU) has long been used to evaluate the urinary tract. Over the years, use of excretory urography has become less common as a result of cross-sectional imaging techniques but it has remained in general use because of its low cost, availability and ready acceptance by urologic surgeons.¹ Despite these trends IVU can produce problems in patients who tolerate iodinated contrast media poorly or have renal failure. The use of ionizing radiation may also be an issue especially in children

and young adults. However positive results for most entities other than urinary tract calculi often dictate further imaging. It may be possible to avoid a multi-modality work up with its associated cost if similar information were available from a single imaging modality. Developments of magnetic resonance imaging (MRI) of static fluid has led to the emergence of MR urography (MRU) as a potential imaging technique of the urinary system.² MR-Urography should be considered when there are contraindications to IVU, impairment of renal excretion and failure to locate the level of obstruction. The absence of ionizing radiation favours this study during pregnancy.

Magnetic resonance (MR) urography has two different imaging strategies. One is heavily T2-weighted turbo spin echo sequences employed for obtaining unenhanced static-water images of the urinary tract. The other, the T1 – weighted MR urographic technique which imitates conventional intravenous pyelography therefore referred to as excretory MR urography.

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Aims and objectives

- 1) To correlate the clinical presentation, cause of obstruction, degree of obstruction, age-sex distribution and blood urea levels in cases of obstructive uropathy.
- 2) To find out the aetiological factors causing obstructive uropathy by MR Urography.
- 3) Detailed study of the aetiological factors in all cases.

MATERIALS AND METHODS

This study was conducted at Osmania Medical College, Hyderabad over a period of 18 months, on patients having symptoms such as flank pain, haematuria and dysuria. A total of 35 patients were included in this study with ages between 1 and 78 years. These patients first underwent screening USG using Philips Affinity HD 50 ultrasound machine and patients showing hydronephrosis on screening USG, and normal serum creatinine (<1.5 mg/dL) levels were subjected to IVU.

Informed consent was taken from patients. After adequate bowel preparation, IVUs were done using noniodinated contrast media, Omnipaque 300 at a dose of 1.5 ml/kg body weight (approximately 60 ml in adults). Patients were carefully observed for any adverse contrast reaction in the meantime, and emergency drugs were kept standby. Plain films followed by films at 7, 15, 30 min, full bladder and post voiding films and 24 hr films (whenever required) were taken. Patients in whom there was no contrast excretion at 24 h, poor contrast excretion, persistent nephrogram or diagnosis was not clear on IVU and those with contrast reactions on IVU were subjected to MRU.

92 MRU was done using 1.5 Tesla Magnetom (Avanto Siemens Germany) using the standard circular body coil with use contrast material in the case of dynamic MRU. The contrast material used was 0.1 mmol of Gadodiamide (Omniscan) per kg body weight.

MRU sequences were repeated 5 and 15 min after the administration of contrast material and delayed films were taken when necessary. Subsequently, detailed MRUs and finally, the source images were performed until completion of the examination after usually 25–30 min of contrast material injection. The total imaging time for complete MR urography was approximately 30–35 min. in the majority of patients.

Diuretic enhanced excretory MRU was performed using a breath hold sequence in the coronal plane with an anteriorly located presaturation slab. MRUs were obtained with are petition time ms/echo of 7/2.8, a 30° flip angle, a 1.8–2.2 mm section thickness and an overlap of 1 mm, two signals.

Acquired, a 128 × 210 matrix. Field of view was adjusted individually to accommodate different patient sizes. Before contrast material injection, a heavily T2 weighted MR urogram was obtained using a half Fourier acquisition singles hot turbos pin echo (HASTE) sequence in coronal plane followed by conventional axial T2 weighted turbo spin echo sequence of the kidney or the pelvis.

The HASTE sequence was applied in the axial, sagittal and coronal planes. The data were compiled and computed for various results.

RESULTS

The present study was carried out in Osmania Medical College and General Hospital. Total of 35 patients have taken part after elaborate discussion with them and after informing about the study design and protocol.

35 patients were scanned by MR Urography who showed the clinical and biochemical signs of hydronephrosis and hydroureter. Out of these 35 patients, all patients were detected to have hydronephrosis and/or hydroureter and MR Urography could be able to locate the cause of dilatation of pelvicalyceal system.

Out of these 35 cases, few cases were cross-checked by USG and few cases were cross-checked by excretory urography.

In the present study majority were males (60%) and female patients were 40%. Out of 35, 8 cases each (22.85%) are in the age group 21–30 years and 31–40 years which forms the largest group. 7 cases each (20%) in the groups 31–40 years and 41–50 years respectively. The younger patient is 1 year old, and the oldest patient is 78 years old.

Out of these 35 patients, 41% urinary tracts (some patients showed bilateral hydronephrosis and hydroureter) showed the evidence of dilated pelvicalyceal system and ureter. Out of all patients, majority of cases (37.1%) are due to calculus disease (n=13) followed by pelvi-ureteric junction obstruction (17.1%) (n=6), stricture ureter (8.6%) (n=3), Carcinoma bladder (8.6%) (n=3), Ureterocoele (n=2), Cystic disease (n=2), 1 each due to pyelonephritis, VUJ stricture due to reflux, Megaloureter, psoas collection Horse-shoe kidney and bladder diverticulum. Two cases were found to have no detectable cause.

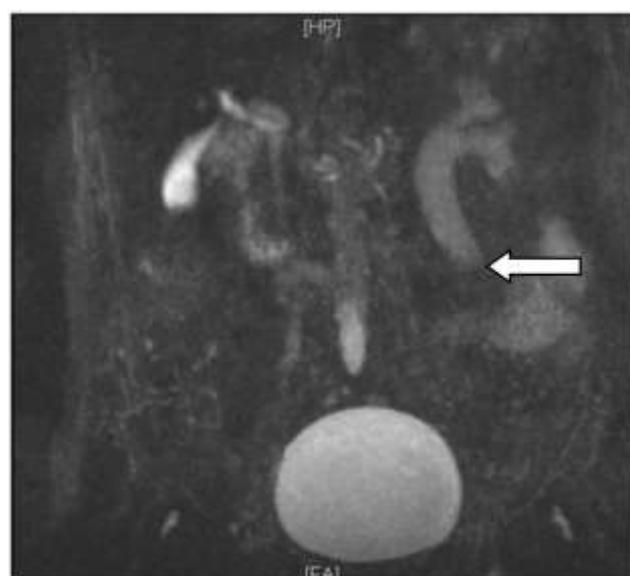


Figure 1. HASTE MR Urography of 67 yrs. old female showing mild hydroureteronephrosis on the left side due to mid ureteric stricture (white arrow).



Figure 2. Source MR urogram image of 60 yrs. old male shows huge hypointense filling defect (arrow) in right side of bladder, partially infiltrating VUJ (arrowhead)



Figure 3. MR Urography image of 15 yrs. old male showing gross hydronephrosis on the left side due to PUJ obstruction (black arrow)

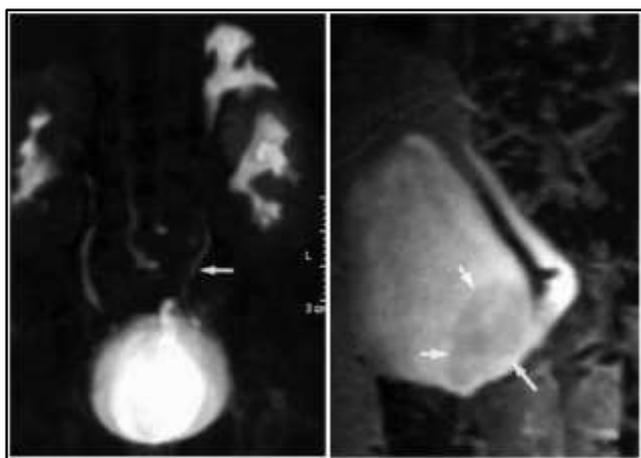


Figure 4. MR Urography of 36 yrs. female showing duplex collecting system (white arrow) on the left side with ureteroceles. (multiple arrows)



Figure 5. MR Urography of 12 yrs. old male shows bilateral ureteroceles (arrows) with bilateral moderate hydronephrosis and bilateral mild hydroureters

DISCUSSION

This study entitled "Role of magnetic resonance urography in detecting the causes in patients with clinically suspected obstructive uropathy" included 35 patients.

The MR urography was performed using 1.5 Tesla MRI Machine (Siemens Medical Systems) Dilated urinary tract or hydronephrosis is found to be more commonly unilateral (80%) and the commonest age group is 21-30 years. Males are more commonly affected (M:F = 1.5:1) among the various clinical presentation, the most common is only pain abdomen (54.28%). Two or more complex clinical symptoms are present in 38.46% of patients.

The commonest cause of unilateral hydronephrosis is calculus disease (39.30%) followed by pelvi-ureteric junction obstruction (14.30%). Majority of unilateral hydronephrosis is on the right side (60.71%) and with mild degree dilated collecting system (57.10%). There is male predominance noted (M: F = 1.5:1) and majority show normal blood urea level (75.00%).

The commonest cause of bilateral hydronephrosis is again calculus disease (42.85%), followed by pelvi-ureteric junction obstruction (14.28%). Majority of bilateral hydronephrosis is presented with moderate degree dilatation of collecting system (71.42%). There is male predominance noted (M:F = 1.33:1) and majority show normal blood urea level (57.14%).

The most common clinical presentation in patients with calculi is only pain abdomen (46.15%) and majority show mild hydronephrosis (46.15%). The commonest location is in the upper ureter (53.86%). Males are affected for more commonly (M:F~5.5:1). Calculi arc found to be common on right side (69.24%) and to present with normal blood urea level (84.61%).

Clinical Presentation

Out of the 35 cases of clinically suspected obstructive uropathy, 23 cases (65.8%) show obstruction in the upper urinary tract and 12 cases (34.2%) show lower urinary tract

obstruction. So, majority of cases show upper urinary tract obstruction.

The chief clinical complaint in the study group was abdominal pain and haematuria. Some cases presented with loin to groin pain, dysuria and incontinence. Associated symptoms include fever, weakness, giddiness etc. However, some cases were asymptomatic too, but with high blood urea levels.

Symptoms referable to upper urinary tract obstruction were pain, mass per abdomen, abdominal distension, burning micturition, frequency, continuous dribbling, fever, vomiting, decreased appetite.

Symptoms referable to mid- and lower urinary tract obstruction were dribbling, thin stream, pelvic pain, burning micturition, haematuria, fever, abdominal distension.

For easy analysis of data, we have divided urinary tract into 3 parts.^{1,2}

- a) Upper - pelvis or ureter and upper ureter till the lower border of kidney.
- b) Mid - From lower border of kidney till the point where ureter enters into the pelvic cavity where it crosses bifurcation of common iliac artery.
- c) Lower - From the entrance of the pelvic cavity till the level where ureter opens into the bladder. It has three parts, as vertical, oblique and intravesical part.

In the present study pain abdomen was found to be the single commonest clinical presentation (54.28%). Though typical loin to groin pain was found to be rare, diffuse upper abdominal pain was quite common. The clinical presentations being Mass per abdomen (8.57%), haematuria (11.42%) and 25.73% had two or more clinical features.

Out of 19 patients who presented with only pain abdomen, 26.31% (5) of cases showed calculus disease. Out of these calculus diseases, 3 patients (15, 8%) showed ureteric calculi; rest 10.5% patients (2) showed renal calculi.^{2,3} The largest calculus was found 15 mm in the right upper ureter in a 65-year-old female who presented with only pain abdomen. The smallest calculus to cause only abdominal pain was 8 mm, found in the left upper ureter in 57-year-old male who presented with only pain abdomen. Next common cause to present as only abdominal pain^{4,5} was pelviureteric junction obstruction (26.31%). Out of these 5 patients, 4 had right side diseases, 1 had left side and one case was bilateral disease. Out of these 5 patients, 4 were female and one was male which shows the disease is common in females and on the right side. The remaining (42.10%) patients showed pain abdomen due to other causes.

Out of 19 patients who presented with only pain abdomen, majority (63.2%) of cases showed mild degree hydronephrosis and hydroureter. 31.6% showed moderate degree hydronephrosis-hydroureter, and the remaining had severe degree hydronephrosis-hydroureter.

Out of our total study group of 35 patients, only 8.6% were presented with only mass per abdomen. Out of these 3 patients who presented with only pain abdomen,^{4,5}

majority were children 1-2-year-old, only 1 patient was adult. All cases showed moderate to severe degree of hydronephrosis-hydroureter. All patients showed raised blood urea levels. Majority of cases was detected to have congenital muscular developmental defects. 2 cases showed ureterocoele-megaureter defects, and 1 case showed pelviureteric junction obstruction.

In the present study 11.4% were presented with only haematuria. Only two causes were found to present as only haematuria. 50% of patients who presented with only haematuria showed invasive bladder carcinoma, and remaining had ureteric calculus diseases. The sizes of calculi were 6 mm and 22 mm. All cases (100%) were males, and all were adults. Only one patient showed highly raised blood urea level, rest 3 cases showed normal blood urea level.

Other non-specific symptoms that are associated with any or all of the above symptoms are- distension of abdomen, loss of appetite, significant Weight loss, fever etc.

In the present study 46.16% cases had mild degree of obstruction, 30.77% showed moderate degree hydronephrosis-hydroureter and the remaining had severe obstructive changes.

The sizes of calculi were also calculated. The largest calculus found was a staghorn calculus measuring 65mm in 28-year-old female, but showed only minimal hydronephrosis. The smallest calculus found was right lower ureteric calculus measuring 6mm in 53-year-old male and showed only minimal hydronephrosis.

Location of calculi also was taken into account. Majority (61.53%) of calculi, which produces symptoms, was found in the ureter, out of 13 cases, only 5 patients (38.5%) showed renal calculi, rest 8 cases (61.53%) showed ureteric calculi. Out of the 8 ureteric calculi, majority was found in the upper ureter. 7 patient (88% of all ureteric calculi) showed upper ureteric calculi, and rest only 1 case showed lower ureteric calculus.

Out of 13 cases of calculus diseases, the most common presentation was with normal blood urea levels. 11 cases (84.62%) showed normal blood urea levels, 1 patient showed mildly elevated blood urea and rest 1 patient showed highly raised blood urea level.

Sex ratio in calculus diseases also calculated. Majority of patients are male (84.62%), only 2 patients were female. All patients were adults. The youngest patient was 25-year-old male and the oldest was 78-year-old male.

Laterality was also counted. Out of 13 cases, majority (92%) is unilateral. Most of the cases were right-sided calculi. 9 cases (69.2%) showed right side obstruction, 3 cases (23.1%) showed left-sided calculi, and only 1 case showed bilateral calculi.

When heavily T2W technique is used for Magnetic Resonance Urography, urinary calculi are identified as foci of partial or complete absent intraluminal signal intensity surrounded by bright signal intensity from urinary tract oedema likely caused by a combination of their low mobile proton density and T2 relaxation values.^{6,7} This bright signal intensity from urinary tract oedema helps to differentiate ureteric calculi from phlebolith. Because MIP images are

projectional images that selectively displays high signal intensity pixels, the bright signal intensity from urine may entirely surround a calculus and obscure it.⁸ For this reason, all images must be reviewed to detect calculi. Visualization of urinary tract beyond the obstructive site is a major advantage over other modalities.

Pelvi-Ureteric Junction Obstruction (17.1%)

This was found to be the next common cause of dilated pelvicalyceal system. Out of total 35 patients, 6 cases were found to have PUJ obstruction, which forms 17% of all study population.

Out of 6 cases of PUJ obstruction, it was possible to diagnose the site, grade and level of obstruction by MR-Urography in all cases.

The degree of hydronephrosis and hydroureter was calculated. Out of 6 cases of PUJ obstruction, majority showed moderate degree hydronephrosis. Total 4 cases (66.7%) showed moderate degree hydronephrosis. Only 1 case (16.7%) showed severe degree hydronephrosis; and only 1 case (16.7%) showed mild degree hydronephrosis.

Out of 6 cases of pelvi-ureteric junction obstruction, the most common presentation was only pain abdomen. 5 cases (83% of all pelvi-ureteric junction obstruction) presented with only pain abdomen, 1 case (16.7%) presented with only mass per abdomen. No case was found to present as haematuria.

Out of 6 cases of pelvi-ureteric junction obstruction diseases, the most common presentation was with normal blood urea levels. 4 cases (66.7%) showed normal blood urea levels, 2 patients (33.3%) showed mildly elevated blood urea and none of the patients showed highly raised blood urea level.⁹

Sex ratio in calculus diseases was also calculated. Majority of patients are female (66.7%), only 2 patients were male. All patients were adults (83.3%) except one, who was 1.5-year-old child. The youngest patient was 1.5-year-old male and the oldest was 52-year-old female.

Laterality was also counted. Out of 6 cases, majority (83%) is unilateral. 3 cases (50%) were right-sided Pelvi-ureteric junction obstruction. 2 cases (33.3%) showed left side obstruction, and only 1 case (16.7%) showed bilateral Pelvi-ureteric junction obstruction.

The single most important criterion to diagnose Pelvi-ureteric junction obstruction was dilated pelvicalyceal system with normal visualization of the distal urinary tract, which appear as hyperintense on T2 weighted and HASTE sequences. (Figure 3)^{6,8}

Out of 35 cases of hydronephrosis, majority is unilateral. 28 cases (80%) were unilateral, rest 20% cases were bilateral.

The degree of hydronephrosis and hydroureter was calculated. Out of 28 cases of unilateral obstruction, majority showed mild degree hydronephrosis. Total 16 cases (57.1%) showed mild degree hydronephrosis. Only 4 cases (14.3%) showed severe degree hydronephrosis; and rest 8 case (28.6%) showed moderate degree hydronephrosis.

Out of 28 cases of unilateral diseases, the most common presentation was only pain abdomen. 15 cases (53.6%) presented with only pain abdomen, 4 cases (14.3%) presented with only haematuria, 3 cases (10.7%) presented with only mass per abdomen and rest 6 patients presented with two or more symptoms.

Sex ratio in unilateral hydronephrosis diseases was also calculated. Majority of patients were male (60.7%), 11 patients (39.3%) were female. Out of total 17 male, 8 had mild hydronephrosis, 5 had moderate hydronephrosis and 4 had severe hydronephrosis. No female patient had severe hydronephrosis.

Laterality was also counted. Out of total 28 cases of unilateral hydronephrosis, 17 cases (60.7%) were right-sided obstruction. 11 cases (39.3%) showed left side obstruction.

Out of 28 cases of unilateral hydronephrosis, the most common presentation was with normal blood urea levels. 21 cases (75%) showed normal blood urea levels, 5 patients (17.9%) showed mildly elevated blood urea and 2 patients (7.1%) showed highly raised blood urea level

Bilateral Hydronephrosis

Out of total 35 cases, 07 cases are bilateral. The different aetiologies were as follow.

The degree of hydronephrosis and hydroureter was calculated. Out of 07 cases of bilateral obstruction, majority (71.43%) showed moderate degree hydronephrosis. Total 02 cases (28.57%) showed mild degree hydronephrosis. No case was reported with severe degree of hydronephrosis.

Out of 7 cases of bilateral diseases, the most common presentation was only pain abdomen. 4 cases presented with only pain abdomen, no cases were presented with only haematuria, 1 case presented with only mass per abdomen and rest 2 patients presented with two or more symptoms.

Sex ratio in bilateral hydronephrosis diseases was also calculated. Majority of patients were males (04), 03 patients were females. Out of total 04 male, 1 had mild hydronephrosis, 3 had moderate hydronephrosis and none had severe hydronephrosis. No female patient had severe hydronephrosis.

Out of 7 cases of bilateral hydronephrosis, the most common presentation was with normal blood urea levels. 4 cases showed normal blood urea levels, 1 patient showed mildly elevated blood urea and 2 patients showed highly raised blood urea level.

Stricture Ureter

Out of 35 cases, 2 cases were found to have stricture ureter. Both were females, aged 28 and 67 years respectively. Both cases showed left sided disease and upper and mid-ureter involvement (Figure 1). Blood urea levels were mildly raised in both of the cases. Both of the cases presented with only pain abdomen.

MRI showed narrowing of the mid ureters with diameter less than 4 mm and proximal dilated urinary tract.

Ureterocoele

Out of 35 cases, 3 cases were found to have ureterocoele (Figure 4). 02 cases were females and 01 case was male. Majority of cases (02) showed right sided disease. One case showed bilateral disease (Figure 5). Blood urea levels were normal in majority of cases (02). Majority (02) of the cases presented with only pain abdomen.

MRI showed dilated hyperintense ureter on HASTE sequence with normal distal ureter. The constricted segment is abnormal in development, proximal segment showed dilatation in normally developed segment.¹⁰

Carcinoma Bladder

Out of 35 cases, 03 cases showed bladder malignancy. All cases were males in the age group of 40 to 70 years, had a history of prolonged exposure to dye factory. All of the cases showed lower ureteric involvement with moderate degree hydronephrosis and all of the cases were presented with Frank haematuria.⁹

On MRI primary bladder tumours are hypointense on T2 and HASTE, mostly epithelial in origin and showed involvement of the muscular layer of lower ureters. (Figure 2) Uphill obstructive changes also could be evaluated.⁷

Other diseases included were; pyelonephritis, VUJ stricture, psoas collection, Horse shoe kidney and bladder diverticulum.⁹

Blood urea level was also taken into consideration to assess renal function. Very high urea level was seen in 5 cases, 2 cases showed carcinoma bladder, one patient was found to have staghorn renal calculus, one patient showed multiple renal cortical cysts and the other patient showed bladder diverticulum.

The most common clinical presentation in patients with pelvi-ureteric junction obstruction is only pain abdomen (83.33%) and majority show moderate hydronephrosis (66.70%). Females are affected for more commonly (M: F- 1: 2). Pelvi-ureteric junction obstruction are found to be common on right side (50.00%) and to present with normal blood urea level (66.66%).

Only two cases with mild degree hydronephrosis show no obvious pathology that could be picked up by MR urography. However, after taking proper clinical history, it was found to be due to post passage residual dilatation. Both of them passed calculi in recent past.

Thus, MR urography using HASTE sequence is very accurate in cases of hydronephrosis. So, in near future it may emerge as an alternative to the other available radiological investigations.

CONCLUSION

MRU delivered highest accuracy to demonstrate the cause, level and degree. It however 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.

REFERENCES

- [1] Williams PL, Bannister LH, Berry MM, et al. *Grays Anatomy*. 38th edn. London: ELBS Churchill Livingstone 1995.
- [2] Keats TE, Siström C. *Atlas of radiologic measurements*. 7th edn. London: Mosby Publication 2001.
- [3] Datta AM. *Essentials of human anatomy*. 6th edn. Calcutta, Mumbai: Current Books International 2001.
- [4] Bailey H, Love M. *Bailey and Love's short practice of surgery*. 23rd edn. London: Hodder Arnold Publications 2003.
- [5] Das S. *A concise textbook of surgery*. 2nd edn. Calcutta: SD Publisher 1999.
- [6] Grainger RG, Allison D, Adam A, et al. *Grainger & Allison's diagnostic radiology*. 4th edn. London: Churchill Livingstone 2001.
- [7] Button D. *Textbook of radiology and imaging*. 7th edn. London: Churchill Livingstone 2003.
- [8] Haaga JR, Lanzieri CF, Gilkeson RC. *CT and MR imaging of the whole body*. 4th edn. London: Mosby Publications 2003.
- [9] Dunnick NR, Sandier CM, Newhouse JH, et al. *Textbook of urology*. 3rd edn. Philadelphia: Lippincott Williams & Wilkins 2001.
- [10] Hwang SI, Kim SH, Kim YJ, et al. Effectiveness of MR urography in the evaluation of kidney which failed to opacify during excretory urography: comparison with ultrasonography. *Korean J Radiol* 2000;1(3):152-158.