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COMPARATIVE ROLE OF COMPUTED TOMOGRAPHY AND MAGNETIC RESONANCE UROGRAPHY INURINARY TRACT CALCULI

RUNNING TITLE: CT VS MR UROGRAPHY IN URINARY TRACT CALCULI

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ABSTRACT:

Background: Prevalence of urolithiasis is increasing in modern society due to a variety of etiologiesand due to high recurrence rates. Though computed tomography is an imaging modality of choice to detect the calculus along with their number & location especially in ureter, susceptibility of its disintegration on lithotripsy, obstructive signs and delineating the roadmap for surgery in complicated cases but recently there are growing concerns related to radiation exposure especially in children, pregnant women, psychiatric patients and follow up cases. There is a recent interest in magnetic resonance urography (MRU) that combines the advantage of cross-sectional imaging &urography with simultaneous avoidance of contrast-related & radiation risk. Hence, we conducted a pilot study for evaluating the diagnostic ability of MRU in urolithiasis patients.

Materials & Methods: This observational,cross-sectional, comparative study was performed in the Department of Radiodiagnosis on 20 patients diagnosed with urolithiasis by 128-Slice CT scanner. MRU was performed on 1.5T MR scanner utilizing T2 weighted images in multiple planes. Data was recorded in blinded fashion and analysed using appropriate statistical tools & methods.

Results: MRU revealed an overall detection rate of 65% for urolithiasis but was able to depict the obstructive signs clearly even when the calculus was not visualised yielding an overall capability of 100% in predicting future course of action. The major limitation was in detection of calculus $\leq$6mm and those located in distal ureter or vesicoureteric junction.

Conclusion: Though MRU cannot replace the CT scan in patients with urolithiasis, yet it can be used as an alternative imaging tool to evaluate urolithiasis with a considerable degree of

confidence & accuracy especially in predicting the future course of management in such patients.

Keywords: Computed Tomography, Magnetic Resonance Urography, Urolithiasis.

INTRODUCTION:

Urolithiasis is being detected at an increasing rate in modern society due to variety of reasons.[1]It presentsmainly with flank pain, haematuria,dysuria or obstructive symptoms like oliguria, increased frequency, incompetency, or lower abdominal pain. Till date computed tomography (CT) is the standard modality of imaging in urolithiasis.[1]

CT scan scores over other imaging modalities due to itsrapid acquisition, high sensitivity, high specificity, and capability of assessing associated pathologies needed not only for diagnosis but also for treatment planningin cases of urolithiasis.[1]These advantages are partially neutralized by the use of ionizing radiation, a major concern in pregnant females and children.[2]The issue of radiation exposure is more significant in patients of urolithiasis due to high recurrence rates and need for repeated follow up in psychiatric patients.

Though ultrasonography (USG), undoubtedly is safer imaging modality avoiding harmful effects of radiationswith advantages of time efficiency and easy availability, but it has limited utility in small calculi, calculus in middle& lower third ureter.[2]Obesity and bowel gases are also major hinderances to detection of calculi by USG.Other limitations of USG include failure to provide useful surgical information like type of renal pelvis, exact location of ureteric calculus, number of calculi; interobserver variability and difficulty encountered in uncooperative patients as well as small children.

To overcome the drawbacks of ultrasonography and radiation exposure in CT scan, magnetic resonance urography (MRU)has evolved as a suitable alternative in urolithiasis. A calculus is seen as a filling defect in the high intensity urine on T2-weighted weighted image (T2WI).[3]Additionally, the secondary effects of urolithiasis needed for surgical planning are also well-depicted by MRU.[3]

Hence,we conducted a pilot study to compare MR urography with CT scan in assessment of urolithiasis patients in our hospital settings.

MATERIALS & METHODS:

This observational, cross sectional, comparative and blinded study was conducted in the department of Radiodiagnosis of our institutionon *twenty patients* using strict inclusion & exclusion criteriaand following approval from Institutional Ethics Committee &written informed consent.

Inclusion Criterion

- Patient having urolithiasis on CT scan.

Exclusion Criteria

- Severe claustrophobic patients.
- Previous history of allergy to iodinated contrast if contrast-enhanced CT scan was required.
- Renal function test not in normal range (serum creatinine>1.3mg/dL, GFR<60 ml/min)[4]in case of contrast CT urography was required.
- Contraindications to MR Urography.

CT Scan Protocol

CT scan was done on multidetector, helical,128 slice, Philips Ingenuity CT scannerthrough the KUB region during breath-holding with a reconstruction of 5mm slices.In cases of

contrast enhanced CT scan, iodinated contrast was administered intravenously in a dose of 0.75-1.25ml/kg body weight of 300mgI contrast with nephrogenic and excretory phases.
Most CT scan examinationsincluded noncontrast (unenhanced), nephrographic (enhanced) and excretory (urographic) images.

MR Urography Protocol
MR imaging was performed on a 1.5Tesla, SIEMENS AVANTO, MR scanner using breath-holding T2WI sequence with thin section slice thickness of 1-2mm. For fat-suppressed, T2WI of the renal parenchyma, respiratory–triggered, fast spin echosequence was used. Axial, coronal & sagittal images of all sequences were assessed to comparethe diagnostic performance of MR urography.Imaging findings was recorded in a single blinded fashion.

OBSERVATIONS AND ANALYSIS:

(Image 1-3)
Our study included twenty patients of urolithiasis with two patients having two calculus each. The mean age in our study group was 28yrs while male forming the majority group.
Table 1 shows that out of 20 patients with urolithiasis on CT scan, MRU could detect calculus in only 13 patients with a detection rate of 65%.
Table 2 shows that out of total 22 calculi (as 2 patients had two calculus on CT scan), 14 calculi were detected on MRU which were measuring $\geq$7mm in length including one patient with two calculus. This yielded a detection rate of 70% for calculus $\geq$7mm with an overall detection rate of approximately 63%.
Table 3 shows that out of total 22 urinary tract calculus (as 2 patients had two calculus on CT scan) 14 calculus were detected on MRU. MRU could detect 7 of 9 renal, 6 of 11 ureteric and 1 of 1 vesical calculus yielding a detection rate of 78%, 55% & 100% for renal, ureteric & vesical calculus respectively. One case of VUJ calculus on CT scans was not detected on MRU. It is clear that MRU has a major failure rate in cases of ureteric calculus.
Table 4 shows that 17 out 20 cases showed obstructive features on CT scan while only three cases had no features of obstruction. All cases were accurately assigned to obstructive and non-obstructive group by MR Urography.
In addition to the above, we noted that all calculi (7/20) having an attenuation value of >970HU on CT scan had a signal intensity of <515 SI while those (13/20) with an attenuation value of <970HU, had a signal intensity of >515SI.

Table 1: Comparison of MRU vs CT scan based on detection of calculus

Patients with Urinary Tract Calculus on CT Scan	Patients with Urinary Tract Calculus on MRU	Detection Rate of Calculus / Accuracy of MRU in %age
20	**13**	**65**

Table 2: Comparison of MRU vs CT scan based of size of calculus[5,6]

Size of Calculus in mm	Calculus Detected on CT scan	Calculus Detected on MRU
$\leq$6	**2 (9%)**	**0**
$\geq$7	**20 (91%)**	**14 (70%)**

Table 3: Comparison of MRU vs CT scan basedon Location of Calculus.

Location of Calculus	Calculus Detected on CT scan	Calculus Detected on MRU
Renal	**9**	**7 (78%)**
Ureter	**11**	**6 (55%)**
Vesicoureteric Junction	**1**	**0 (0%)**
Vesical	**1**	**1 (100%)**

Table 4: Comparison of MRU vs CT scan based on Obstructive Signs.

Obstructive Features	Number of Patient on CT scan	Number of Patient on MRU
Present	**17**	**17 (100%)**
Absent	**3**	**3 (100%)**

DISCUSSION:

In our pilot study,13 patients of urolithiasis were diagnosed accurately by the MRUaccounting for 65% accuracy. The accuracy in our study is lower than that reported by MazenSudah et al[2]and DipaliKadam et al[7]with a reported MR urography accuracy of 93% & 82% respectively. The higher accuracy in previous studies is probably due to higher field strength of the MR scanner used in these studies i.e. 3Tesla instead of 1.5Tesla in our study.

In our study, 2 cases of calculus $\leq$6mm escaped detection on MRI while 14 out of 20 calculi with size >6mmin length were detected accurately on MRU (70%) yielding an overall accuracy of 63%. However, ureteric calculus $\leq$6mm in length are usually managed conservatively by hydration & analgesics while those larger than 6mm usually require surgical intervention as stated by Fielding JR et al& Mun Ki Min et al.[6,8]Based on the above fact, MRU was able to predict the future course of management of 16/22 calculus with an overall accuracy of 73%.

In our study, 7 of 9 renal calculus and only 6 of 11 ureteric calculus were detected by MRU.All calculus in the upper ureter were detected by MRU but those that escaped detection were primarily located in the distal part of ureter showing the area of limitation of MRU. A single case of vesical calculus was detected by MRU but that of vesicoureteric junction calculus escaped detection on MRU. Our results are similar to a study by SeminsMJ et al[1]that revealed high accuracy of MRU in detecting upper ureteric stones. They also stated the superior ability of MRU in detecting perinephric fluid compared to CT scan in cases of ureteric calculi signifying obstruction requiring intervention.

Our study group of 20 patients of urolithiasis were divided into those with calculus causing obstruction and those with calculus without obstruction.The former group included 17 patients that were accurately diagnosed by MRU and rest 3 patients were grouped as calculus without obstruction. In 11 out of 17 patients with calculus causing obstruction, the calculus was detected on MRU with 5 missed in distal ureter & one at vesicoureteric junction. However, the calculus was well detected in 2 out of 3 patients with calculus without obstruction by MRU. Based on the above facts, MRU could predict or detect calculus for further management in significant percentage of patients with urolithiasis yielding an accuracy of 65% in detection of calculus and accuracy of 100% in predicting further course of management. Our results are similar to that reported in a study by Semins MJ et al[1] with an accuracy of nearly 47% in detecting calculus in urinary tract and specificity of 100% for obstructive signs.

KalbBet al[3]also stated that the size of calculus and presence of signs of obstruction likeperinephricedema/fluid increases the diagnostic potential of MRU in patients of urolithiasis. They also stated that MRU has better resolution for the detection of secondary effects of obstruction (perinephricedema/fluid and severity of dilatation of renal collecting system or ureter), perinephric fat stranding, vascular details, etc.[3,9]
IdirOuzaid et al[5]in their study on 50 patients concluded that calculus attenuation value of 970HU is a specific and sensitive threshold as there are minimal changes of stone disintegration with a Dolis lithotripter at higher attenuation value. In our study, we correlated thisattenuation value of calculus with signal intensity on MRU and found that calculus with CT attenuation value of <970HU had an intensity of >515SI on MRU performed on 1.5Tesla MR scanner.

CONCLUSIONS:

- MRU has an overall accuracy of 65% in detection of calculus.
- MRU is very accurate in detection of calculus ≥7mm & those located in kidneys, upper ureter & urinary bladder while it is poor in detection of calculus ≤6mm in length and those located in distal ureter or vesicoureteric junction.
- MRU is very useful in predicting management in patients of urolithiasis as it detects the signs of significant obstruction with 100% accuracy.

SUMMARY:

Though detection of calculus is a major concern on MRU, but detection of obstructive signs provides a clue in the management of patients with urolithiasis by providing the severity & level of obstruction. Thus, MRU can be considered as a possible alternative to CT scan which is an existing gold standard imaging modality for urolithiasis especially in patients with radiation concerns like children, pregnancy, psychiatric disease & recurrent cases with follow-up.

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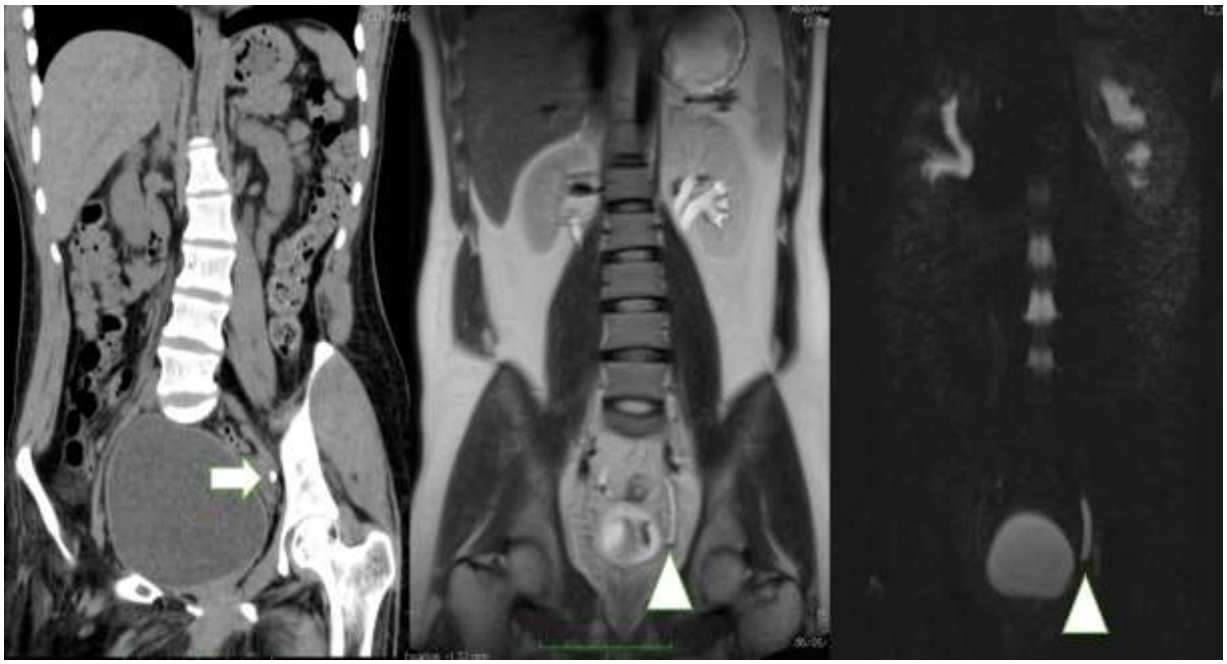

Image 1: Coronal MPR noncontrast CT image (left) shows a small left distal ureteric calculus seen well on Coronal T2W MR image (middle) & Coronal MRU image (right) with associated proximal hydroureter.

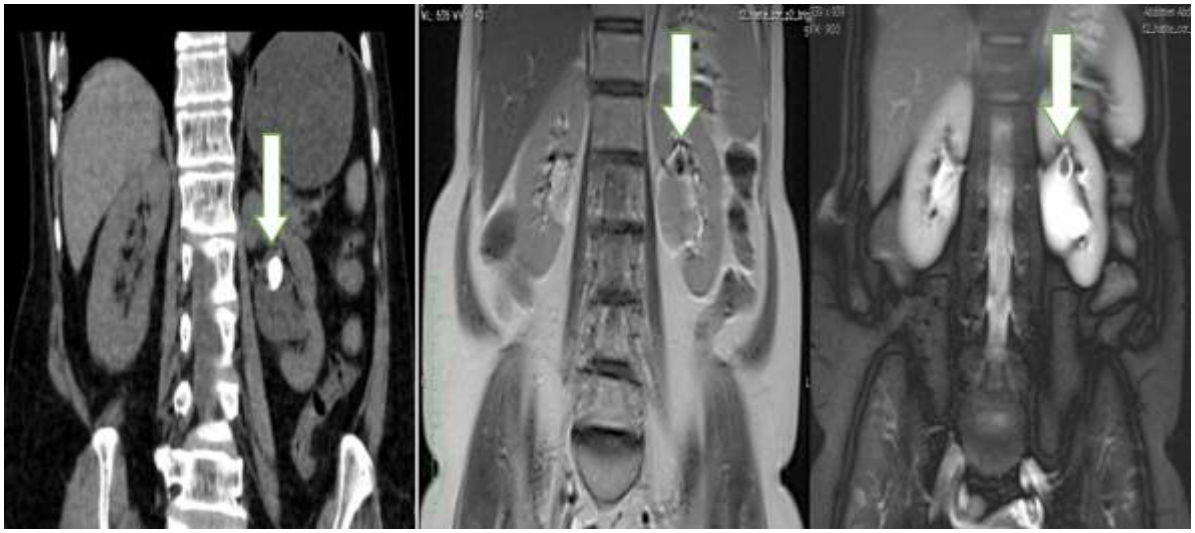

Image 2: Coronal MPR noncontrast CT image (left) shows a small left renal pelvic calculus seen well on Coronal T2W MR image (middle) & Coronal MRU image (right) with large extrarenalpelvis.

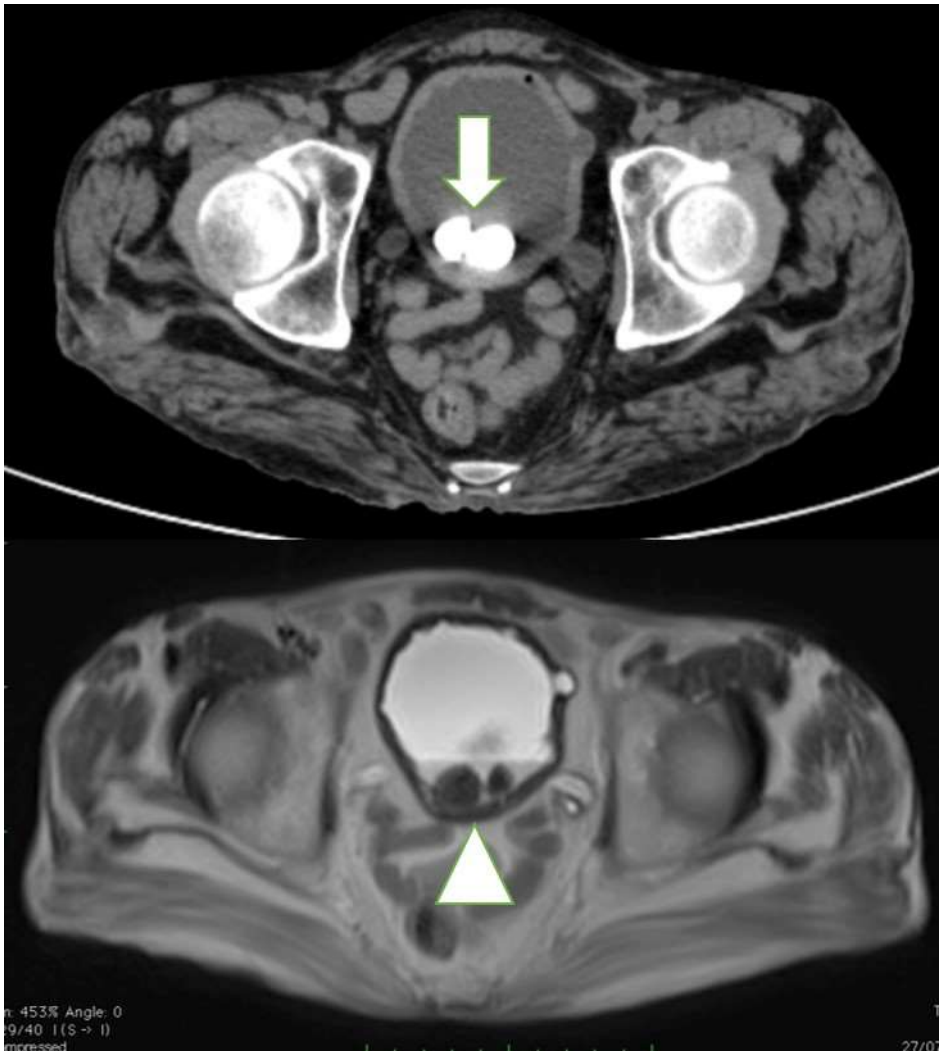

Image 3: Transaxialnoncontrast CT image (upper) shows two vesical calculus with vesical wall thickening & small diverticulum in left lateral wall seen clearly on axial T2W MR image (lower) also.