MAK HILL Publications Research Journal of Medical Sciences

Research Article
doi: 10.59218/makrjms.2024.6.137.141

Role of Static Magnetic Resonance Urography in Evaluation of Hydronephrosis in Pediatric Patients with Deranged Renal Function

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ABSTRACT

When evaluating pediatric patients, Magnetic Resonance Urography (MRU) is a superior imaging modality that offers detailed anatomical imaging of the urinary tract and renal system. This study assessed the function of static MRU in pediatric hydronephrosis patients to identify the degree and cause of obstruction. Using ultrasonography (USG), pediatric patients with hydronephrosis were assessed for anatomical aberrations and levels of obstruction and the representation of congenital malformations. This was an observational study prospectively conducted at a tertiary-level medical college and hospital over a period of 2 years. Thirty cases of pediatric patients with deranged renal function and hydronephrosis on ultrasonography were subsequently evaluated using heavy T2 weighted static MRU sequences on a Philips Achieva 1.5 T MRI system using a pediatric body coil. Data was acquired on a pretested proforma and quantitative data were processed to yield statistical Mean and SD values. 40 cases (69%) were males. The average age in this study was 4.4±4.3 years. The youngest patient was two months old and the oldest was 17 years. The most common diagnosis in this study was ureteropelvic junction (UPJ) obstruction, which was seen in more than half of patients (30 or 51.7%), followed by cases having ureterovesical junction (UVJ) obstruction (11 or 19%), VUR was seen in 9 (15.5%) cases and pyelonephritis in 7 (12.1%) and one patient (1.7%) had bilateral megaureter. When the value of the renal function obtained with DRS and CHOP-fMRU methods were compared, no statistically significant differences were observed between these two methods. . The average value according to the DRS method was 46.9±18.9% (range 0-87%) and according to CHOP-fMRU, 47.6±21.5% (range 8.3-100%) in cases of left kidney. The mean DRS value was 53.4±18.4% (range 13-100%), while CHOP-fMRU was 51.8±22.4 (range 0-96.7%) in cases of right kidney. Static MR-Urography is a superior imaging modality in pediatric patients with impaired renal function and hydronephrosis on USG. It is the best imaging modality for a thorough assessment of obstructing lesions in pediatric patients with hydronephrosis observed on USG for both congenital and acquired lesions. Lesions in the kidney were found to be the most common cause of obstructive uropathy, followed by those in the pelvis and ureters. More pediatric patients with congenital lesions than those with acquired lesions were seen in the presentation.

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Key Words
Hydronephrosis, Urography, Scintigraphy, Kidney, Paediatrics

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Received: 18 March 2024
Accepted: 20 April 2024
Published: 24 April 2024

Citation: Anish Choudhary, Navya Mishra, Mayank Shekhar and Biplaw Balraj, 2024. Role of Static Magnetic Resonance Urography in Evaluation of Hydronephrosis in Pediatric Patients with Deranged Renal Function. Res. J. Med. Sci., 18: 137-141, doi: 10.59218/makrjms.2024.6.137.141

INTRODUCTION

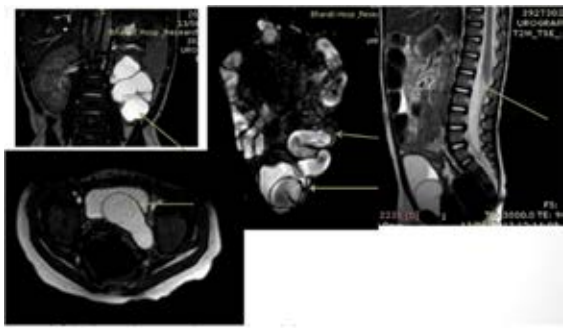
A condition known as congenital hydronephrosis (CH) causes the renal pelvis to dilate, either with or without the renal calyxes' dilatation[1]. It can be identified from the twelfth to the fourteenth week of gestation and is diagnosed by prenatal ultrasound examination. Since the beginning of the 1970s, prenatal ultrasound examinations have become more and more common for the diagnosis of fetal abnormalities. Prenatal ultrasound was used in the early years of pregnancy and detected structural abnormalities in about 1-3% of cases. Confirmation of hydronephrosis, identification of its cause and assessment of renal function are the three main objectives of the postnatal evaluation of CH. In addition to limiting needless radiological searches and thereby minimizing the number of children and parents who experience the same results but are clinically insignificant or normal, postnatal evaluation has the challenging and responsible task of identifying newborns and children with significant abnormalities of the kidney or urinary tract that require surgical treatment[2]. In the past, patients with CH were assessed using intravenous urography (IVU). Dynamic renal scintigraphy (DRS) combined with diuretic administration is the preferred approach for evaluating renal function and drainage. It has been demonstrated that magnetic resonance urography (MRU) is the urinary tract imaging modality that offers the most significant advantages for children. MRU has the capacity to present both morphological and functional data in a single review. Since no ionizing radiation is involved, children can safely use this method. Functional magnetic urography is used to assess the obstruction site, identify anatomical and structural anomalies of the urotract morphologically and determine relative renal function. The functional studies conducted in comparison with scintigraphy have demonstrated a high degree of compatibility between these two methods when determining the kidney's relative renal function, which is the opposite of renal excretion. Additionally, the use of functional magnetic resonance urography analysis, along with the CHOP-fMRU software (developed by The Children's Hospital of Philadelphia, Philadelphia, Pennsylvania, United States of America), allows for the correlation of functional parameters of the kidneys obtained by dynamic renal scintigraphy and magnetic resonance urography, opening the door to more standardized, multicenter studies and the receipt of evidence-based results[3,4].

MATERIALS AND METHODS

A hospital-based prospective study was conducted over a period of two years in patients less than two years of age who were found to have hydronephrosis and/or hydroureter on sonography.

Twenty patients under two years of age were evaluated using heavy T2-weighted static MR urography sequences on a Philips Achieva 1.5 T MRI system with a pediatric body coil.

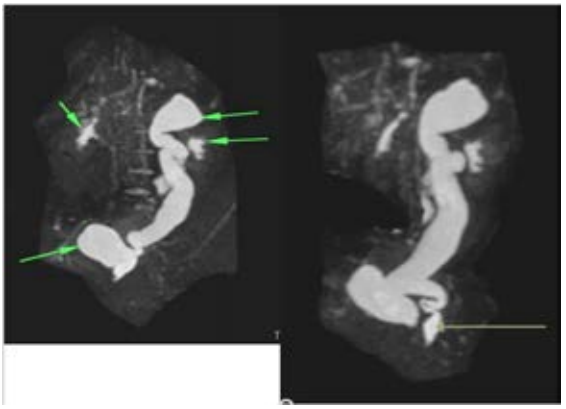
CASE 1: c/o imperforate anus. Gross left hydronephrosis with parenchymal thinning.



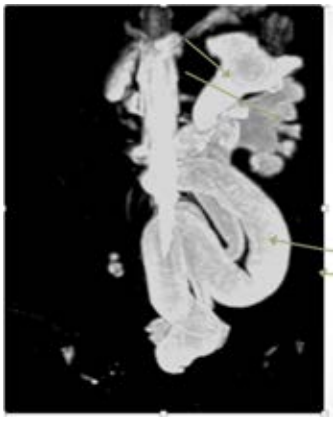
Tortuous and grossly dilated left ureter with associated ureterocele, posteriorly attached filum. The child also had multiple vertebral anomalies.

VACTERL/VATER/KAUFMAN'S SYNDROME

Two cases of complete ureteric duplication.

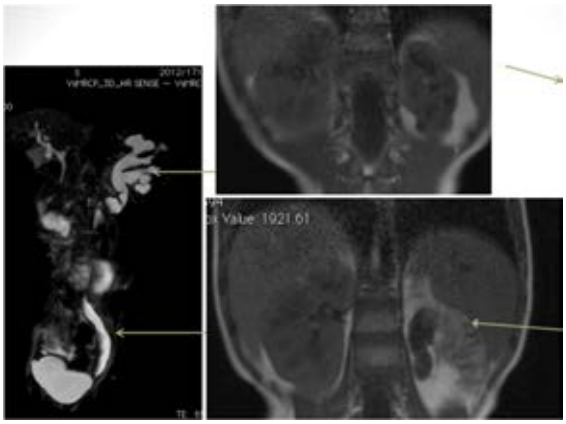


CASE 2: Duplex moiety left with complete left ureteric duplication, dilated upper moiety with ectopic insertion of upper ureter in the vagina.



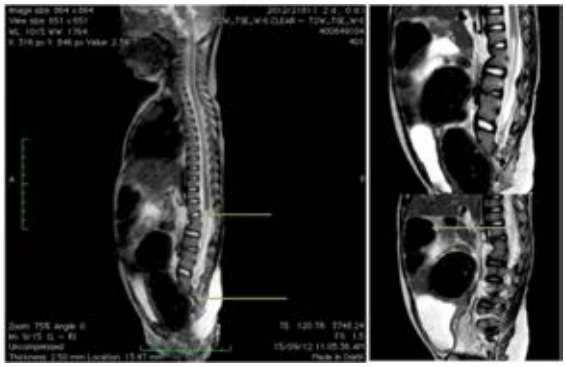
CASE 3: Complete duplication left with both ureters inserting in the bladder.

CASE 4: Small left kidney, irregular in outline. Dilated left PC system with dilated upper and lower ureter.

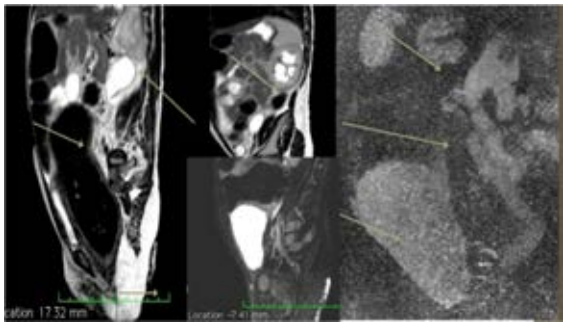


Follow-up DMSA scan revealed a poorly functioning left kidney and reflux demonstrated on MCU.

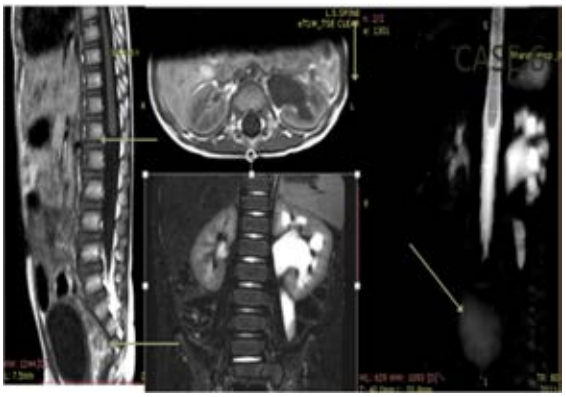
CASE 5: Partial sacral agenesis, abrupt termination of conus, multiple vertebral anomalies.



Tubular bladder, overdistended rectum, left hydroureteronephrosis in a case of caudal regression syndrome, suggesting neurogenic bladder, vesicoureteric reflux. It is confirmed on an MCU.

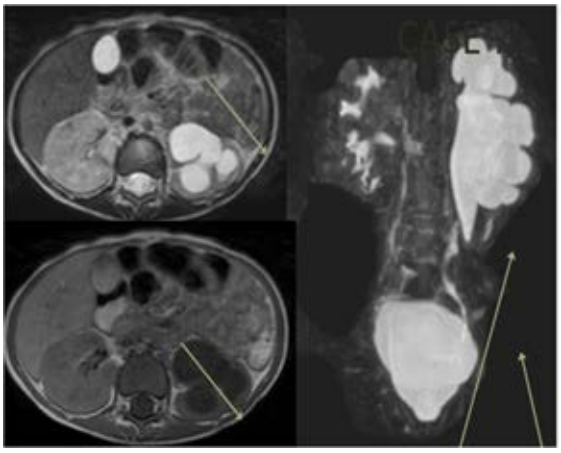


CASE 6: Truncated conus ending abruptly at D12-L1 level. Only three sacral segments seen.

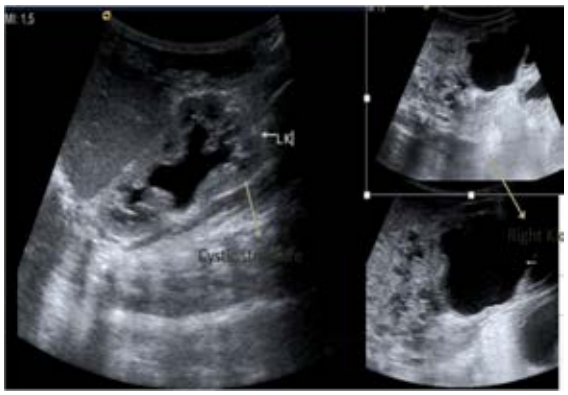


Left hydroureteronephrosis in another case of caudal regression syndrome

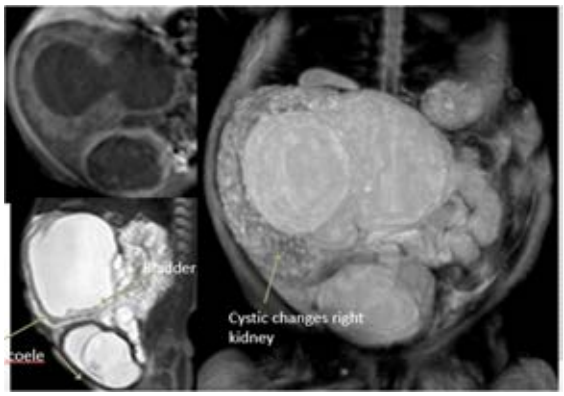
CASE 7: Dilated left PC system normal middle and distal ureter. Normal right kidney and ureter Left Pelvi-ureteric junction obstruction.



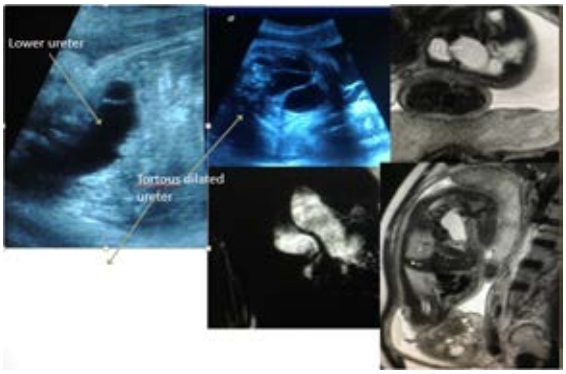
CASE 8: 18 day old baby presented with abdominal distension.



USG revealed a large cystic structure in the right half of the abdomen, left PC system fullness Cystic structure found to be ureterocoele, grossly dilated tortuous right ureter seen. Enlarged right kidney with duplex moiety.



CASE 9: Antenatal USG revealed gross left hydronephrosis with hydroureter, a fetal MR Urography confirmed the same.



RESULTS AND DISCUSSIONS

The study included 60 subjects with CH. Male patients were represented in 40 cases (69%). The youngest patient in our study was 2 months old and the oldest was 17; the average age was 4.4±4.3 years (Table 1).

The most common diagnosis in this study was ureteropelvic junction (UPJ) obstruction, which was seen in more than half of patients (30 or 51.7%). This was followed by cases having ureterovesical junction (UVJ) obstruction (11 or 19%). VUR was seen in 9 (15.5%) cases, pyelonephrosis in 7 (12.1%) and one patient (1.7%) had bilateral megaureter. Positive anamnesis of urinary tract infections was noted in 44 (75.9%) cases.

No statistically significant difference was found when the value of renal function was obtained with DRS and CHOP-fMRU. When the right kidney was evaluated, the mean DRS value was 53.4±18.4% (range 13-100%), while CHOP-fMRU was 51.8±22.4 (range 0-96.7%). In this study, the average value according to the DRS method and CHOP-fMRU was 46.9±18.9% (range 0-87%) and 47.6±21.5% (range8.3-100%) respectively(Table) in the evaluation of the left kidney. The correlation coefficient between these two methods were statistically significant.

Table 1: Proof of correlation of the method in evaluating relative renal function (dynamic renal scintigraphy)

Comparison between average values of DRS and CHOP-fMRU	N	Mean	SD
DRS-right kidney	60	53,421	1,84,390
DRS-left kidney	60	46,900	1,88,825
CHOP-fMRU-right kidney	60	5,17,983	22,42,478
CHOP-fMRU-left kidney	60	4,76,352	21,52,839

Anomalies of the renal system and urinary tract may not be the cause of CH, but they can. Prenatal ultrasound examinations are the most common method of diagnosis in developed nations. Out of the 60 participants in our study, only 25 (43.1%) had a prenatal diagnosis of hydronephrosis. Until now, no single approach has been able to offer all the data required for a trustworthy assessment of the circumstances. Conventional methods have numerous drawbacks, such as the lower third of the ureter flow visualization being challenging to visualize during an ultrasound examination that depends on the examiner, the invasive nature of retrograde methods like retrograde pyelography and the low anatomical resolution of scintigraphy[5]. Nowadays, new techniques have been created to overcome traditional techniques' limitations and magnetic resonance urography (MRU) is a most appealing available technological method. MRU is a technique that impacts therapeutic procedures for congenital malformations and other urogenital anomalies in children and it promises early diagnosis. This non-ionizing radiation-based diagnostic approach offers a comprehensive visual representation of the different morphological anomalies of the genitourinary system. Steering clear of ionizing radiation is one of the most crucial childhood diagnostic strategies[6]. Once VUR is turned off, VCUG/UMCG magnetic urography provides a comprehensive and highly spatially resolved view of the kidney and urinary morphology. The presence of a cystocele, a duplicated duct system, corticomedullary differentiation, the degree of hydronephrosis or ureterohydronephrosis and the location of obstruction can all be reliably ascertained by it.

UPJ stenosis was the most frequently reported diagnosis, accounting for more than half of cases (30 or 57%), according to diagnostic entities. DRS is a standard procedure in the assessment and monitoring of CH in obstructive uropathy. After twenty years, much work has gone into standardizing the processes. Due to a higher renal excretion rate and rapid plasma clearance, tubular radioisotope Tc-99 m MAG-3 is preferred over glomerular radioisotope Tc.99m DTPA. This is highly important in patients with impaired renal function, newborns and children[7]. Determining the relative renal function is a more reliable method of estimating renal obstruction than using DRS to estimate renal excretion[7]. The growing curve is highly prone to blockage, but spot-flushing

radiopharmaceuticals can readily evaluate the unstructured system. The response is measured using straightforward metrics like Time to Peak (TTP) (<3 min) and the half-life of radiopharmaceutical rinsing.

In evaluating the response to the applied radio-pharmacy, additional quantitative parameters (such as parenchymal transit time, outcome efficacy, pelvic excretion efficiency and normalized residual activity) are used for renal function drainage assessment. According to the literature, none of the parameters enable the unquestionable interpretation of diuretic renography in kidney damage cases[8]. Consequently, measurement of renal function is even more crucial than diuretic response assessment. Differential renal function, which typically ranges from 45 to 55 percent, is the percentage that each kidney contributes to the total sum of renal activity. A decline in differential renal function of more than 5% on subsequent diuretic renal scintigraphy, or a differential renal function below 40%, is typically regarded as a sign of declining renal function, potentially due to obstructive uropathy[9]. MRU is a valuable technique for evaluating dilated urinary tracts. Without ionizing radiation, the method provides information on renal function and high anatomical resolution. Apart from magnetic urography, no other diagnostic technique that integrates morphological and functional criteria into a single, non-ionizing radiation-based method has been reported thus far for the evaluation of CH. According to recent scientific research, fMRU can estimate urinary tract obstruction that would need surgical intervention[10]. It is necessary to correlate the morphological and functional parameters carefully. While the CHOP-fMRU software design facilitates a cursory examination of functional parameters in pediatric radiology departments, the proper case judgment can only be reached by meticulously examining morphological and functional parameters[10].

We compared the relative renal function determined by dynamic renal scintigraphy and magnetic resonance urography in our sample of sixty patients with CH of various etiologies. With a high degree of coincidence in estimating the relative renal function between the DRS and fMRU methods, statistical measurements have demonstrated a statistically significant correlation between these two methods. Similar findings are seen in other clinical investigations[10].

CONCLUSION

Based on the findings, magnetic resonance urography should be a crucial component of the management of these patients in the pediatric CH population, particularly in cases of congenital obstructive uropathy and complex congenital anomalies, as it offers anatomical and functional information on the condition of the kidneys and urinary tract. When evaluating renal function based on multiple parameters and comparing it to morphological parameters, a thorough analysis is required.

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