



A STUDY TO ASSESS THE ROLE OF RENAL DOPPLER ULTRASONOGRAPHY IN DIFFERENTIATING BETWEEN OBSTRUCTIVE AND NONOBSTRUCTIVE UNILATERAL HYDRONEPHROSIS IN INFANTS AND CHILDREN

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ABSTRACT

It remains a challenging task for the paediatric urologist to differentiate between obstructive and nonobstructive hydronephrosis in children. This study aimed to evaluate the role of renal Doppler ultrasonography in diagnosing obstruction, in unilateral equivocal hydronephrosis, by measuring intrarenal resistive index in both, hydronephrotic as well as in contralateral healthy kidney and comparing the data. This prospective study was done in the Department of Radiodiagnosis of MGM Medical College & M.Y. Hospital, Indore (M. P.), from MAY-2017 to JULY-2018, in 62 patients (<16 years age), having unilateral urinary tract dilatation. In this study, PUJ obstruction was found to be the most commonly seen unilateral obstructive pathology, and VUR was the most frequent nonobstructive pathology. The mean RI, RIR and DRI values of hydronephrotic kidneys were significantly higher (0.82, 1.13, 0.09) in obstructive cases, than in non obstructive cases (0.77, 1.02, 0.03). The sensitivity, specificity and diagnostic accuracy of the mean RI, in our study was found to be 93.75%, 33.33% and 64.52% respectively, and for the RIR and DRI, 87.50%, 90.00% and 88.70% respectively. Thus, because of its high sensitivity and specificity, the colour Doppler ultrasound study of intrarenal renal arteries, holds a unique role in imaging workup as well as in optimal management planning, in cases of unilateral paediatric hydronephrosis.

KEYWORDS :

INTRODUCTION

The dilation of the pelvicalyceal system (Hydronephrosis) is not always equivalent to the obstruction of the urinary tract, it can be nonobstructive too. Vesicoureteral reflux (VUR) is a common cause of nonobstructive hydronephrosis. In fact, upon initial screening, it may be indistinguishable from obstructive hydronephrosis. Unrelieved urinary tract obstruction has been shown to interfere with normal development of the kidney in young children and almost always leads to permanent renal atrophy, termed obstructive uropathy. So it is quite necessary to distinguish between significant obstruction and nonobstructive cases. If the obstruction persists, intrarenal diastolic arterial flow velocities are decreased, renal blood flow continues to fall, resulting in decreased glomerular filtration rate and elevated renal resistive index (RI) because of vasoconstriction caused by renin, angiotensin, and other hormones. Ultimately, the volume of the cortex begins to diminish because of tubular atrophy. Therefore by assessing this increased resistance in intrarenal arteries (i.e. segmental and arcuate) by doppler ultrasound, we can distinguish between significant obstruction (that requires surgical intervention) and nonobstructive cases (in which only conservative approach is appropriate). Following Renal doppler indices were calculated in our study for the discrimination – Renal Resistive Index $[RI = (\text{Peak systolic velocity} - \text{end diastolic velocity}) / \text{peak systolic velocity}]$, Resistive Index Ratio $(RIR = RI \text{ of hydronephrotic kidney} / RI \text{ of healthy kidney})$, and Delta RI $(DRI = RI \text{ of hydronephrotic kidney} - RI \text{ of healthy kidney})$.

Thus the purpose of our study was to evaluate the importance of renal Doppler ultrasonography in diagnosing obstruction, in Unilateral equivocal hydronephrosis cases. A high renal resistive index $(RI > 0.7)$ in hydronephrotic kidney, a resistive index difference $(\Delta RI) > 0.05$ and resistive index ratio $(RIR) > 1.10$ between healthy and hydronephrotic kidney, detected by Doppler ultrasound is suggestive of renal obstruction while a $RI < 0.7$ generally indicates non obstructive dilatation^[1-2]. RI values are age-dependent^[3] it declines with increasing age (normal paediatric renal $RI = 0.7-0.8$, even > 0.8 in some cases) and often operator- and equipment-dependent too. Therefore in neonates and infants, it is much more easier and useful to compare values of RI of both the kidneys, by using RIR and ΔRI ^[3] in unilateral hydronephrosis. The RIR and DRI does not show any statistically significant relationship with the age^[4]. On combining the RIR and ΔRI , increases the accuracy of the test^[3,5,6].

SUBJECTS AND METHODS

This prospective study was done after taking a written informed consent from the parents/ guardian of the patients, by using an efficient colour doppler machine, in 62 patients (under 16 yrs age) having unilateral hydronephrosis, who were either pre diagnosed by other modalities like MCU, CT-IVP, CT Whole abdomen, Renography etc. or diagnosed with our Grey scale USG study. The subject of study is age specific. Only children upto 16 years of age were included in the study. Renal morphology was evaluated in longitudinal, transverse and oblique plane (in both side) in each patient, using Siemens equipment's, 2.5 to 5-MHz transducer. In every patient, Doppler ultrasonography of intrarenal renal arteries was carried out, using 2.5 - 5 MHz transducer, in both kidneys. At least 5 doppler spectra were obtained from five different regions of each kidney, including poles and the middle echocomplex part, and mean was calculated. Determination of mean RI, RIR, ΔRI were done, then data was analyzed statistically, to evaluate the diagnostic accuracy of the technique. Patients above 16 years of age, or having bilateral hydro / pyonephrosis / traumatic or iatrogenic hydronephrosis / renal mass lesions were excluded from the study.

OBSERVATIONS AND RESULTS

A total of 32 (48%), out of 62 patients, were found to have obstructive hydronephrosis and 30 (48%) were having non obstructive hydronephrosis. In obstructive cases, PUJO was most commonly seen, 25 (78%) followed by calculus, 4 (13%), ureterocele, 2 (6%) and ureteric narrowing, 1 (3%). In non obstructive cases, VUR was most frequent, 22 (73%) followed by neonatal HN with unknown causes (idiopathic hydronephrosis of newborns), 3 (10%), ureteric duplication, 3 (10%) and extrarenal pelvis, 2 (7%), (shown in Table 1-2). The most common age group of the patients (children) in our study, was between 1-6 months, (26%), followed by between 5-10 yrs, (22%). The percentage of affected male children (73%) was significantly higher than the affected females (27%) with a male:female ratio approximately 2.6 : 1. Most common presenting complaint was abdominal pain, seen in 38 (61%) cases followed by dysuria 28 (45%), fever 20 (32%) and, pyuria 6 (10%). In present study, on comparing the two groups obstructive and nonobstructive, the mean RI values in the healthy kidneys did not differ much, while in hydronephrotic kidneys the difference in RI values were significant. The mean ΔRI was also found to be significantly higher (0.09) in obstructive cases than in nonobstructive (0.03) cases. Similarly the mean RI and the RIR values of hydronephrotic kidneys were found to be significantly

higher (0.82, 1.13)in obstructive, than in non obstructive cases (0.77, 1.02).(shown in Table 3-4).

TABLE 1: CAUSES OF OBSTRUCTIVE HYDRONEPHROSIS

S. No.	Cause of Obstructive Hydronephrosis	No. of pts.	Percentage %
1	PUJO	25	78 %
2	Calculus	4	13 %
3	Ureterocele	2	6 %
4	Ureteric narrowing	1	3 %
	Total	32	100 %

TABLE 2: CAUSES OF NONOBSTRUCTIVE HYDRONEPHROSIS

S. No.	Causes of Nonobstructive Hydronephrosis	No. of pts.	Percentage %
1	Vesico-ureteric reflux (VUR)	22	73 %
2	Neonatal HN with unknown causes	3	10 %
3	Ureteric duplicatoin	3	10 %
4	Extrarenal Pelvis	2	7 %
	Total	30	100%

TABLE 3: MEAN RESISTIVE INDEX (RI) VALUES

Mean RI value in obstructive and non obstructive HN (Normal range- 0.7 to 0.8)		
Type of Hydro nephrosis	Healthy Kidney	Hydronephrotic Kidney
Obstructive	0.73	0.82
Non Obstructive	0.74	0.76

TABLE 4: MEAN RESISTIVE INDEX RATIO (RIR) & MEAN DELTA RI

Mean RIR& DRI in obstructive and non obstructive HN (Mean RIRNormal range: 1.01-1.09,Mean DRINormal range: 0.01- 0.05)		
Type of Hydronephrosis	mRIR	mDRI
Obstructive	1.13	0.09
Non-obstructive	1.02	0.03

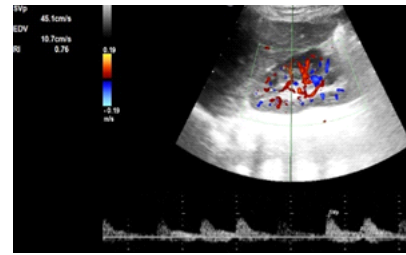
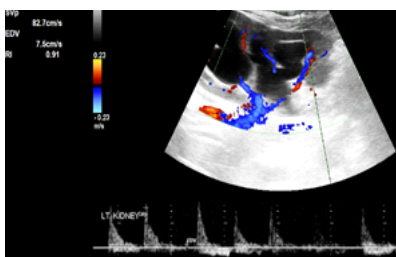
Case 1. A 2 yrs male, with left PUJ Obstruction



Left kidney

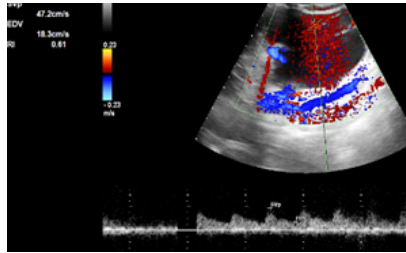


Right kidney

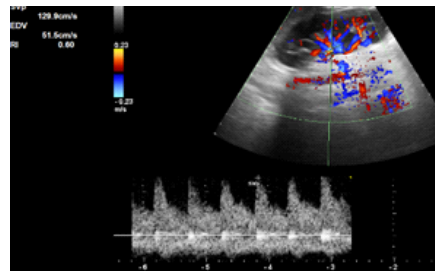


The RI of left obstructed kidney was significantly higher (0.91) than the RI of healthy right kidney (0.76).

Case 2. A 10 months/M with left nonobstructive hydronephrosis (left VUR)



Left kidney



Right kidney

No significant difference was seen in resistive index (RI) values of both the kidneys (right- 0.61, left- 0.60), suggestive of nonobstructive hydronephrosis.

DISCUSSION

The availability of doppler sonography is apparently a simple, non invasive and well reproducible adjunct to the other partly invasive /high cost diagnostic procedures, commonly used in the radiological assessment of the renal obstruction. The measurement of the renal indices (RI, RIR and Delta RI) by Doppler Ultrasound, are reliable indicator of urinary tract obstruction according to various previous studies^[4,6,7,10-12,15-22]. The present study comprised of a total 62 patients. The most common age group of the patients (children) in our study, was between 1-6 months, 16 (26%), followed by 5-10 yrs, 14 (22%), This is in accordance with the previous studies done by Ordorica RC. et al^[7], and Lim GY et al^[4]. Males were predominated (73%) over females (27%) with a male:female ratio of about 2.6 : 1, our result correlates well with the previous study done by Kristy VanDervoort et al^[8]. and Nuraj Pet al^[9]. Most common presenting complaint was abdominal pain, seen in 38 (61%) cases followed by dysuria 28 (45%), fever 20 (32%) and pyuria 6 (10%). Abdominal pain was recorded as the most common symptom in the previous studies also, done by Gilbert R. et al^[10], Brkljacic B. et al^[11], and Granata A. et al^[12]. Increased renal length along with cortical thinning in affected kidney (RCT < 5.9 mm.), was seen in 26 (42%) patients. Out of this 26 patients, 16 (50 %) cases were obstructive whereas 10 (33 %) cases were nonobstructive. This indicates severe grade (Grade IV) hydronephrosis, These findings are in accordance with the previous studies done by Jeremy C. Kelley et al^[13], and Pepe P. Motta L et al^[14].

In obstructive cases, hydronephrotic kidneys RI was found to be significantly higher as compare to the healthy side, but in non obstructive cases it is nearly equal or slightly more than the healthy side. This is well correlated with the previous studies done by G. Patti et al^[15], Juraj Svitar. et al^[16], Z Ashraf, et al^[17], Aneela Azamet al^[18]. Mean

RIR in our study, in obstructive cases was found to be 1.13, that is more than the normal (normal range is 1.01-1.09), and in nonobstructive cases, it was 1.02 (within the normal range). Our results are in accordance with the studies done by Lim GY et al^[4], Brkljadic B et al^[11], and Umamageswari Amirthalingam et al^[19]. Mean Delta RI in our study was found to be 0.09, that is above the normal range (normal range is 0.01-0.05) in obstructive cases and 0.03, that is within the normal range in non obstructive cases. The studies done by Haroun A et al^[20], Onur MR1 et al^[21], Granata A1 et al^[12] and Raza Sayani et al^[22], also had similar results.

In our study most of the obstructive patients, 28 (87%) had their mean RIR ≥ 1.1 , while most of the non obstructive patients, 27 (90%) had their mean RIR < 1.1 . Thus our result, suggesting that RIR value ≥ 1.1 is indicative of obstruction and < 1.1 indicates nonobstructive dilatation, is in accordance with previous studies done by Lim GY et al, Brkljadic B et al and Umamageswari Amirthalingam et al. Similarly most of the obstructive cases, 28 (87%), had their mean DRI value > 0.05 , whereas most of the non obstructive cases, 27 (90%), had their mean DRI value ≤ 0.05 , suggesting that DRI > 0.05 is indicative of obstruction whereas DRI ≤ 0.05 indicates non obstructive dilatation. This result is also in accordance with previous studies done by Haroun A et al, Onur MR1 et al, Granata A1 et al, and Raza Sayani et al. Thus mean RIR and mean DRI appeared to be more reliable in distinguishing between paediatric unilateral equivocal hydronephrosis.

On calculating the accuracy of mean RI value in diagnosing obstruction, we found 30 true positive and 2 false negative findings on renal doppler study, therefore the sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of the mean RI in this study was found to be 93.75%, 33.33%, 60.00%, 83.33%, and 64.52% respectively. Similarly on calculating the accuracy of mean RIR and DRI in diagnosing obstruction, we found 28 true positive and 4 false negative findings on renal doppler, therefore the sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of the mean RIR and DRI, in this study was found to be 87.50%, 90.00%, 90.32%, 87.09%, and 88.70% respectively. The sensitivity, specificity, PPV and NPV of our study is closely related to the previous studies done by Lim GY et al, Brkljadic B et al, Granata A1 et al, and Raza Sayani et al.

CONCLUSION

The colour doppler ultrasonography of intrarenal renal arteries, holds a unique role in imaging workup as well as in optimal management planning, in cases of unilateral paediatric hydronephrosis. This sensitivity, specificity and the diagnostic accuracy is very high, found to be 87.50%, 90.00% and 88.70% respectively. This is comparable to the other partly invasive /high cost higher modalities of imaging. The diagnostic accuracy of the renal resistive index ratio (RIR) and delta RI (DRI) is found to be very high (88.70%) as compared to the accuracy of the mean RI (64.52%), as they are age independent entities. Therefore gray scale USG should be complemented by doppler ultrasound as an adjunctive imaging modality in all suspected cases of equivocal, unilateral paediatric hydronephrosis.

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