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Anatomical Disorders of Urinary System in Neonates with Prenatal Hydronephrosis

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Abstract

Background: Among urinary tract anomalies, hydronephrosis is particularly important, so it is the most common congenital defect that is detected in a pregnancy ultrasound. The causes of hydronephrosis are varying from transient to severe disorders. This study aimed to evaluate the types of anatomical disorders of the urinary system in neonates with a history of prenatal hydronephrosis.

Methods: In this cross-sectional study, 40 neonates with prenatal hydronephrosis were examined. In infants with severe bilateral hydronephrosis, posterior urethral valve (PUV) in male fetus, dilated bladder, and trabeculae, ultrasound was performed as soon as possible, and in the rest of the infants in 3-7 days. In cases of mild hydronephrosis, the infant was followed, and in moderate and severe cases voiding cystourethrogram (VCUG) was performed in 6-8 weeks. In the absence of vesicoureteral reflux (VUR), a diethylenetriamine pentaacetate (DTPA) scan was performed to exclude obstructive uropathy. The data was analyzed through SPSS 26, using Fisher's exact test and repeated measures ANOVA.

Results: Among 40 neonates (33 boys), the prevalence of anatomical disorders of the urinary system was 77.5%, and Ureteropelvic Junction Obstruction (UPJO) was the most frequent one with 54.8%. In infants with UPJO disorder, the mean anterior-posterior diameter (APD) of the pelvis increased significantly from the second trimester to infancy ($p<0.001$).

Conclusion: The risk of adverse postnatal outcomes is significantly increased by the degree of prenatal hydronephrosis. Prenatal pelvic APD and associated urinary tract abnormalities can predict significant neonatal nephropathy and the need for postpartum surgery. Prenatal consultation with a pediatric nephrologist and urologist is helpful in reducing parental anxiety and facilitating postpartum management.

Key Words: Anatomical disorders, Hydronephrosis, Infants, Neonate, Prenatal.

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1- INTRODUCTION

Hydronephrosis is the most common congenital defect detectable by prenatal ultrasonography (1). The renal ultrasound examination can detect urological abnormalities in 1-2% of fetuses and in approximately 0.5% of newborns (2). Approximately 50 to 87% of all babies with genitourinary abnormalities have hydronephrosis (3, 4). More than 80% of cases of fetal hydronephrosis are diagnosed after 30 weeks of gestation (5). Prenatal hydronephrosis refers to the abnormal dilatation of the fetal renal collecting system (6). A transverse view of the kidney is used to measure the anterior-posterior diameter (APD) of the pelvis when diagnosing fetal hydronephrosis based on the mother's gestational age (7). Prenatal hydronephrosis has many differential diagnoses, from transient cases to basic anatomical disorders including reflux and obstruction.

In most studies, ultrasound is the best way to follow up these neonates after birth. The anteroposterior diameter of the pelvis is essential to decide how to proceed. Many studies confirm that the severity of hydronephrosis has a positive relationship with postpartum hydronephrosis, the need for surgery, and the risk of urinary infection. Fetuses with minimal pelvic dilatation have a low risk of postpartum pathology, while APD > 15 mm in pregnancy is a sign of severe hydronephrosis, and it needs careful follow-up (8). Various opinions exist about patient follow-up; some recommend performing all diagnostic methods, such as urinary cystourethrography (VCUG) and diethylenetriamine pentaacetate (DTPA), while others select methods based on the degree and nature of hydronephrosis (8-11).

Diagnosing fetal hydronephrosis is a diagnostic and therapeutic problem. For these reasons, a present study was conducted to determine the causes of prenatal hydronephrosis as well as the outcomes in infants.

2- METHODS

This cross-sectional study (IR.KAUMS.MEDNT.REC.1399.214) was conducted in Shahid Beheshti Hospital, Kashan, Iran. All neonates who referred to the pediatric nephrology clinic with the main complaint of prenatal hydronephrosis were included in this study. Neonates who did not have hydronephrosis before birth were excluded from the study. The follow-up duration of patients for the final diagnosis of the cause of hydronephrosis varied from 10 days to one year. The classification of hydronephrosis during pregnancy is based on the gestational age. Based on this classification, in the second trimester, a diameter of 5 and 6 mm is considered as mild, 7-10 mm as moderate, and 10 mm or more as severe. In the third trimester, 7-9 mm is mild, 10-15 mm Moderate meters and diameters greater than 15 mm are considered severe (12).

Postpartum ultrasound was performed 3-7 days after delivery to confirm the presence of hydronephrosis. This delay was for preventing the false negative effect of physiological oliguria in the early days of life. In patients with severe bilateral hydronephrosis, evidence of PUV in the male fetus (keyhole sign on ultrasound due to the distention of both the bladder and the urethra, marked distention and hypertrophy of the bladder, hydronephrosis and hydroureter, oligohydramnios and renal dysplasia (13)), distended bladder, or trabeculae, ultrasound was observed on the first day of birth. For the purpose of this study, the degree of hydronephrosis after birth was classified as mild, moderate, or severe hydronephrosis when the anteroposterior pelvic diameter (APPD) was 5–9 mm, 10–14 mm, and ≥15 mm. All ultrasounds after birth were performed by a skilled radiologist, and based on the table in the

radiology reference, he determined the thickness of the right and left kidney parenchymal thickness (14). Infants with moderate and severe hydronephrosis were initially subjected to Voiding Cystourethrogram VCUG with negative urine culture to check for vesicoureteral reflux (VUR). In the absence of VUR, a DTPA scan was performed to rule out obstructive uropathy (2) using DTPA, to investigate the causes of obstruction. If hydronephrosis was reported in the ultrasound, Ureteropelvic Junction Obstruction (UPJO) was suspected, and in case of hydroureteronephrosis, the diagnosis was Ureterovesical Junction Obstruction (UVJO). Obstruction in UPJO can be partial. It is because of abnormal smooth muscle arrangements, absence, or hypertrophy, in the proximal ureteral walls that affect the peristaltic function (15). In obstructive cases that have a high probability of needing surgery, according to the opinion of the surgeon, Intravenous pyelogram (IVP) was also used to learn more about the anatomy of the obstruction site. Prophylactic antibiotics were used in neonates and infants with moderate and severe hydronephrosis to prevent urinary infection. The options for patients less than 2 months old include trimethoprim and amoxicillin. Trimethoprim-sulfamethoxazole (TMP-SMX) and nitrofurantoin are used in children older than 2 months due to increased antimicrobial resistance to amoxicillin and ampicillin. The dose of prophylactic drugs is a quarter of the general dose for sensitive infections, which is administered every night (16, 17). The data were analyzed through SPSS 26 by the use of Fisher's exact test and repeated measures ANOVA.

3- RESULTS

Among 40 neonates with prenatal hydronephrosis (33 boys; age range of 1 to 14 days), the prevalence of anatomical disorders of urinary system was 77.5% (31 neonates), and UPJO was the most frequent with 54.8% (17 out of 31 neonates); and eight out of 17 neonates with complete obstruction underwent surgery. Also, due to the fact that some anatomical disorders were mixed, the frequency of VUR (9 out of 31) placed in second rank (**Table 1**).

Table 2 shows that anatomical disorders of the urinary system had a significant relationship with APD of the pelvis (third trimester and infancy) and the thickness of the kidney parenchymal thickness ($p<0.01$). Also, in neonates with UPJO disorder, the mean APD of the pelvis increased significantly from the second trimester to infancy, but in neonates who had at least one of VUR, PUV, neurogenic bladder, or UVJO disorders, the mean APD of the pelvis was significantly different only between the second trimester and the infancy (**Table 3**). Neurogenic bladder determined based on the anatomy of the bladder in VCUG and urodynamic study (UDS) was not used for diagnosis. This view, called pine cone bladder or Christmas tree bladder, elongated and pointed bladder with a thickened or trabeculated wall (18).

4- DISCUSSION

According to our study, 54.8% of the urinary system's anatomical abnormalities were due to UPJO. The mean APD of infants with UPJO disorder increased significantly from the second trimester to infancy, while in other disorders, this relationship was not observed and UPJO was the only anatomical disorder that always had severe hydronephrosis during pregnancy and infancy. On the other hand, none of the transient hydronephrosis cases had severe hydronephrosis during fetal and infancy periods and the thickness of kidney parenchyma was normal in all of them. Accordingly, prenatal hydronephrosis has no correlation with its cause, a fact that has been well documented (5, 19).

Table-1: Frequency distribution of anatomical disorders of the urinary system

Anatomical disorders of the urinary system				N (%)	Need to surgery (N)
Single	UPJO	Right		9 (29)	8 open pyeloplasty
		Left		7 (22.6)	
		Bilateral		1 (3.2)	
	UVJO	Right		0	1 ureteral reimplantation
		Left		3 (9.7)	
		Bilateral		0	
	VUR	Right	Grade I	1 (3.2)	0
			Grade II	1 (3.2)	
		Left	Grade I	1 (3.2)	
			Grade III	1 (3.2)	
		Bilateral		0	
	PUV			1 (3.2)	1 valve ablation
	MCDK			1 (3.2)	0
Mix	VUR (right; Grade IV)+neurogenic bladder			1 (3.2)	1 vesicostomy
	VUR (left; Grade III)+neurogenic bladder			2 (6.4)	2 vesicostomy
	VUR (bilateral; Grade V)+PUV			1 (3.2)	1 valve ablation
	VUR (right; Grade IV)+ neurogenic bladder+PUV			1 (3.2)	1 vesicostomy

UPJO: Ureteropelvic Junction Obstruction/ UVJO: Ureterovesical Junction Obstruction/ VUR: Vesicoureteral Reflux/ PUV: Posterior Urethral Valves/ MCDK: MultiCystic Dysplastic Kidney

Table-2: The correlation of anatomical disorders in the urinary system with sex, pelvic APD and kidney parenchyma thickness

Variables			Anatomical disorder of the urinary system		p-value*
			Yes	No	
Gender	Boy		26 (83.9)	7 (77.8)	1
	Girl		5 (16.1)	2 (22.2)	
Pelvic APD (kidney unit) #	Second trimester	Normal	24 (38.7)	11 (61.1)	0.106
		Mild	23 (37.1)	7 (38.9)	
		Moderate	12 (19.4)	0	
		Severe	3 (4.8)	0	
	Third trimester	Normal	27 (43.5)	8 (44.4)	0.002
		Mild	8 (12.9)	9 (50)	
		Moderate	15 (24.2)	1 (5.6)	
		Severe	12 (19.4)	0	
	Infancy	Normal	26 (41.9)	6 (33.3)	0.000
		Mild	3 (4.8)	9 (50)	
		Moderate	12 (19.4)	3 (16.7)	
		Severe	21 (33.9)	0	
Kidney parenchymal thickness	Normal		12 (38.7)	9 (100)	0.001
	Decreased		19 (61.3)	0	

It should be noted that the reported frequencies are based on right and left kidneys (80 kidneys).

* Fisher's exact test

Table 3. Changes in pelvic APD in neonates with anatomical disorders of the urinary system

Anatomical disorders of the urinary system	N (%) #	Pelvic APD			p-value*	p (pairwise)
		Second trimester	Third trimester	Newborn		
UPJO	17 (54.8)	10.61±4.7	14.72±4. 39	19.22±3.69	<0.001	Second - Third: p=0.002
						Second - Newborn: p<0.001
						Third - Newborn: p<0.001
VUR	9 (29)	8±1.73	9.83±3.26	11.78±1.71	0.004	Second - Third: p=0.349
						Second - Newborn: p=0.006
						Third - Newborn: p=0.199
PUV	3 (9.7)	11±3.58	15±5.93	15.17±5.19	0.040	Second - Third: p=0.065
						Second - Newborn: p=0.018
						Third - Newborn: p=0.793
Neurogenic bladder	3 (9.7)	7.8±1.79	11.4±5.55	12.8±2.59	0.024	Second - Third: p=0.141
						Second - Newborn: p=0.005
						Third - Newborn: p=0.363
UVJO	3 (9.7)	9.33±3.21	12±5.29	16.33±3.88	0.020	Second - Third: p=0.157
						Second - Newborn: p=0.034
						Third - Newborn: p=0.130

UPJO: Ureteropelvic Junction Obstruction/ VUR: Vesicoureteral Reflux/ PUV: Posterior Urethral Valves/ UVJO: Ureterovesical Junction Obstruction

Considering that some neonates had more than one type of anatomical disorder, the total frequency is more than 31 neonates.

* Repeated measure ANOVA

According to Li et al., children with any degree of prenatal hydronephrosis are at an increased risk for postnatal pathology compared to the normal population (20). It is therefore recommended to use ultrasound before and after birth in order to make a more accurate diagnosis.

VUR was the second most common abnormality in this study. There are many challenges regarding when and whether to perform cystography after birth. In patients with prenatal hydronephrosis, VUR is present in 17-38% (21). Due to these differences, we performed VCUG when the patient had severe or moderate hydronephrosis. In this study, the most common underlying abnormalities identified were UPJO and VUR. Our study showed a similar pattern to the studies conducted in other countries (2, 22-24). Based on a study conducted by Kim et al., in 2012 (25), the diagnostic value of fetal APD in the second and third trimesters of pregnancy was investigated in a Korean population to predict postpartum surgery. This study found that, compared with 10 mm APD, the most common standard values for predicting postpartum hydronephrosis and its outcome were APD cutoffs of 5, 8, and 10 mm during the second, early third, and late third trimesters, respectively. As a result of that study, the anatomical disorders of the urinary system in the second and third trimesters of pregnancy were different from those obtained in our work. The incongruence between the results of these studies can be attributed to different reasons, such as the sample size and the cut-off point for determining hydronephrosis in APD.

Hydronephrosis is the most common form of fetal malformations diagnosed by prenatal ultrasound. Its reported incidence is 1-5% of all pregnancies (12), which can be caused by obstructions or reflux. Most of the above-mentioned children are at risk for urinary infections, which can result in kidney damage or scarring. There have been limited studies in this field in Iran, which are not new. Therefore, this study aimed to evaluate the types of anatomical disorders of the urinary system in infants with a history of prenatal hydronephrosis. The main strength of this study is that it investigated hydronephrosis in newborns with a consideration to different trimesters of pregnancy and its relationship with kidney parenchymal thickness, which is not found in other studies.

5- CONCLUSION

Considering the high prevalence of anatomical disorders of the urinary system in neonates born with prenatal hydronephrosis, especially in moderate and severe cases, it is recommended that these cases be examined after birth to prevent kidney dysfunction. Our results show that it is very important to diagnose the cause of prenatal hydronephrosis; because no surgical intervention is necessary in transient cases, and in cases of anatomical disorders, surgery is performed only if kidney function worsens or hydronephrosis progresses.

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